MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

CURRICULUM AND SCHEME

SEMESTER 1

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA1T01	LINEAR ALGEBRA AND MULTIVARIABLE CALCULUS	3-1-0-3	4	4
B	B24ES1T01B	PROBLEM SOLVING AND PROGRAMMING TECHNIQUES (B)	2-1-0-2	3	3
C	B24ES1T07	FUNDAMENTALS OF ELECTRICAL ENGINEERING	2-1-0-2	3	3
D	B24ES1T05B	BASIC CIVIL AND MECHANICAL ENGINEERING (B)	2-2-0-2	4	4
E	B24ME1T01	ENGINEERING GRAPHICS	2-1-2-4	5	4
F	B24ES1L04B	BASIC CIVIL AND MECHANICAL WORKSHOP (B)	0-0-2-2	2	1
G	B24ES1L01B	PROGRAMMING LABORATORY (B)	0-0-3-3	3	2
I	B24MC1T01	LIFE SKILLS	1-0-1-2	2	P/F
J	B24MC1T02	DESIGN THINKING	1-1-0-1	2	P/F
K	B24MC1L01	YOGA AND SPORTS	0-1-1-1	2	P/F
			TOTAL	**30**	**21**

SEMESTER 2

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA1T02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORMS	3-1-0-3	4	4
B	B24PH1T01B	ENGINEERING PHYSICS (B)	2-1-0-2	3	3
C.	B24CY1T01A	ENGINEERING CHEMISTRY (A)	2-1-0-2	3	3
D	B24ES1T08	FUNDAMENTALS OF ELECTRONICS ENGINEERING	2-1-0-2	3	3
E	B24ME1T02	STATICS AND DYNAMICS FOR ENGINEERS	3-1-0-3	4	4
F	B24ES1L05	ELECTRICAL AND ELECTRONICS WORKSHOP	0-0-2-2	2	1
G	B24ME1L01	COMPUTER AIDED MACHINE DRAWING	0-0-3-3	3	3
H	B24PH1L01B	ENGINEERING PHYSICS LABORATORY (B)	0-0-1-1	2	1
	B24CY1L01A	ENGINEERING CHEMISTRY LABORATORY (A)	0-0-1-1		
I	B24MC1T03	PROFESSIONAL COMMUNICATION AND ETHICS	2-0-1-3	3	P/F
J	B24MC1L02	IDEA LAB	0-0-3-3	3	P/F
			TOTAL	**30**	**22**

SEMESTER 3

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA2T03A	COMPLEX VARIABLES AND APPLICATIONS OF PDE	3-1-0-3	4	4
B	B24ME2T01	MECHANICS OF SOLIDS	3-1-0-3	4	4
C	B24ME2T02	MECHANICS OF FLUIDS	3-1-0-3	4	4
D	B24ME2T03	METALLURGY AND MATERIALS SCIENCE	2-1-0-2	3	3
E	B24HU2T02	ENTREPRENEURSHIP AND MANAGEMENT SKILLS FOR ENGINEERS	2-1-0-2	3	3
G	B24ME2L02	MATERIAL TESTING LAB	0-0-3-3	3	2
H	B24ME2L03	MACHINE TOOLS LAB	0-0-3-3	3	2
I	B24MC2T04	UNIVERSAL HUMAN VALUE AND CONSTITUTIONAL RIGHTS	2-0-0-2	2	P/F
J	B24MC2T05	ENERGY CONSERVATION AND ENVIRONMENTAL SUSTAINABILITY	2-0-0-2	2	P/F
M		MINOR	3-1-0-3	4	4
			TOTAL	**32**	**22**

SEMESTER 4

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA2T04B	STATISTICAL ANALYSIS AND NUMERICAL METHODS	3-1-0-3	4	4
B	B24ME2T04	THEORY OF MACHINES	3-1-0-3	4	4
C	B24ME2T05	METROLOGY AND MACHINE TOOLS	3-1-0-3	4	3
D	B24ME2T06	ENGINEERING THERMODYNAMICS	3-1-0-3	4	4
E	B24HU2T01	BUSINESS ECONOMICS AND FINANCIAL MANAGEMENT	3-0-0-3	3	3
F	B24ME2T07	FLUID MACHINES	2-1-0-2	3	3
G	B24ME2L04	MECHANICAL MEASUREMENTS LAB	0-0-3-3	3	2
H	B24ME2L05	FLUID MECHANICS AND MACHINES LAB	0-0-3-3	3	2
M		MINOR	3-1-0-3	4	4
N		HONORS	3-1-0-3	4	4
			TOTAL*	**36**	**25**

SEMESTER 5

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24ME3T01	DYNAMICS AND DESIGN OF MACHINES	3-1-0-3	4	4
B	B24ME3T02	THERMAL POWER ENGINEERING	3-1-0-3	4	4
C	B24ME3T03	MANUFACTURING TECHNOLOGY	3-1-0-3	4	4
D	B24ME3T04	ROBOTICS AND AUTOMATION	3-1-0-3	4	4
E	B24ME3T05	INDUSTRIAL AND SYSTEMS ENGINEERING	2-1-0-2	3	3
F	B24ME3P1x	PROGRAMME ELECTIVE I	2-1-0-2	3	3
G	B24ME3L06	ROBOTICS AND AUTOMATION LAB	0-0-3-3	3	2
H	B24ME3L07	THERMAL POWER LAB	0-0-3-3	3	2
M		MINOR	3-1-0-3	4	4
N		HONORS	3-1-0-3	4	4
			TOTAL*	**36**	**26**

PROGRAMME ELECTIVE I

B24ME3P11	OPERATIONS MANAGEMENT
B24ME3P12	ORGANIZATIONAL BEHAVIOUR & HUMAN RESOURCES MANAGEMENT
B24ME3P13	STRATEGIC MARKETING MANAGEMENT
B24ME3P14	OPERATIONS RESEARCH
B24ME3P15	OBJECT ORIENTED PROGRAMMING
B24ME3P16	DATA ANALYTICS FOR ENGINEERS
B24ME3P17	BASICS OF ARDUINO PROGRAMMING

SEMESTER 6

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24ME3T06	DESIGN OF MACHINE ELEMENTS	3-1-0-3	4	4
B	B24ME3T07	HEAT AND MASS TRANSFER	3-1-0-3	4	4
C	B24ME3T08	FINITE ELEMENT METHODS	3-1-0-3	4	4
D	B24ME3T09	ADVANCED AUTOMOTIVE SYSTEMS	3-1-0-3	4	4
E	B24ME3P2x	PROGRAMME ELECTIVE II	2-1-0-2	3	3
F	B24ME3G1x	OPEN ELECTIVE I	2-1-0-2	3	3
G	B24ME3L08	THERMAL SYSTEMS LAB	0-0-3-3	3	2
H	B24ME3L09	COMPUTER AIDED DESIGN AND ANALYSIS LAB	0-0-3-3	3	2
M		MINOR	3-1-0-3	4	4
N		HONORS	3-1-0-3	4	4
			TOTAL*	**36**	**26**

PROGRAMME ELECTIVE II

B24ME3P21	MAINTENANCE MANAGEMENT AND RELIABILITY ENGINEERING
B24ME3P22	FINANCIAL ENGINEERING
B24ME3P23	TECHNOLOGY MANAGEMENT
B24ME3P24	INDUSTRY 4.0 AND INTERNET OF THINGS
B24ME3P25	DATA STRUCTURES AND ALGORITHMS
B24ME3P26	SYSTEM MODELING AND SIMULATION
B24ME3P27	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
B24ME3P28	ALGORITHMS FOR NON TRADITIONAL OPTIMIZATION

OPEN ELECTIVE I

B24ME3G11	QUANTITATIVE TECHNIQUES FOR ENGINEERS
B24ME3G12	INTRODUCTION TO PRODUCT DEVELOPMENT
B24ME3G13	OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT
B24ME3G14	AUTOMOTIVE TECHNOLOGY
B24ME3G15	NON DESTRUCTIVE TESTING
B24ME3G16	MATERIAL HANDLING SYSTEMS
B24ME3G17	FUNDAMENTALS OF DATA ANALYSIS

SEMESTER 7

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24ME4T01	PROJECT MANAGEMENT	2-1-0-2	3	3
B	B24ME4P3x	PROGRAMME ELECTIVE III	2-1-0-2	3	3
C	B24ME4P4x	PROGRAMME ELECTIVE IV	2-1-0-2	3	3
D	B24ME4G2x	OPEN ELECTIVE II	2-1-0-2	3	3
E	B24HU4T04	DISASTER MANAGEMENT AND INDUSTRIAL SAFETY	2-1-0-2	3	3
G	B24ME4L10	ADVANCED MECHANICAL ENGINEERING LAB	0-0-3-3	3	2
H	B24ME4L11	PROJECT PHASE 1	0-0-6-6	6	3
J	B24ME4L12	SEMINAR	0-0-4-4	4	2
K	B24ME4T02	VIVA VOCE	0-0-0-0	-	1
M		MINOR	3-1-0-3	4	4
N		HONORS	3-1-0-3	4	4
			TOTAL*	**36**	**23**

PROGRAMME ELECTIVE III

B24ME4P31	PRODUCT DESIGN AND DEVELOPMENT
B24ME4P32	ADVANCED DESIGN SYNTHESIS
B24ME4P33	INDUSTRIAL TRIBOLOGY
B24ME4P34	RENEWABLE ENERGY
B24ME4P35	COMPUTATIONAL FLUID DYNAMICS
B24ME4P36	INDUSTRIAL HYDRAULICS
B24ME4P37	ADVANCED METAL JOINING TECHNIQUES
B24ME4P38	ADVANCED MANUFACTURING TECHNIQUES
B24ME4P39	SURFACE ENGINEERING AND COATING TECHNOLOGY

PROGRAMME ELECTIVE IV

B24ME4P41	OPTIMIZATION TECHNIQUES AND APPLICATIONS
B24ME4P42	FRACTURE MECHANICS
B24ME4P43	PRESSURE VESSEL AND PIPING DESIGN
B24ME4P44	FUNDAMENTALS OF UNMANNED AERIAL VEHICLES (UAV)
B24ME4P45	REFRIGERATION AND CRYOGENICS
B24ME4P46	HEAT TRANSFER EQUIPMENT DESIGN
B24ME4P47	ADVANCED NON DESTRUCTIVE TESTING
B24ME4P48	MEMS AND NANOTECHNOLOGY
B24ME4P49	ADVANCED NUMERICALLY CONTROLLED MACHINING

OPEN ELECTIVE II

B24ME4G21	INTRODUCTION TO BUSINESS ANALYTICS
B24ME4G22	PATENTS AND INTELLECTUAL PROPERTY RIGHTS
B24ME4G23	FUNDAMENTALS OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT
B24ME4G24	RENEWABLE ENERGY ENGINEERING
B24ME4G25	INTRODUCTION TO 3D PRINTING
B24ME4G26	FUNDAMENTALS OF COMPOSITE MATERIALS
B24ME4G27	INTRODUCTION TO ACOUSTICS AND NOISE CONTROL

SEMESTER 8

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A, B, C		INTERNSHIP & MOOC COURSES** (3 NUMBERS)			9
		OR			
A	B24ME4P5x	PROGRAMME ELECTIVE V	2-1-0-2	3	3
B	B24ME4P6x	PROGRAMME ELECTIVE VI	2-1-0-2	3	3
C	B24ME4G3x	OPEN ELECTIVE III	2-1-0-2	3	3
		AND			
H	B24ME4L13	PROJECT PHASE 2	0-0-12-12	12	6
M		MINOR PROJECT#	0-0-3-3	3	6
N		HONORS PROJECT	0-0-6-6	6	6
			TOTAL*	30	15

#Can be done in S7 as well

* Semester total does not include the credits of honors and minor courses

** Students can take up the MOOC courses in semester 7 as well. The courses should be from the list approved by the Board of Studies.,

PROGRAMME ELECTIVE V

B24ME4P51	ADVANCED THEORY OF VIBRATION
B24ME4P52	ACOUSTICS AND NOISE CONTROL
B24ME4P53	COMPOSITE MATERIALS
B24ME4P54	GAS DYNAMICS AND JET PROPULSION
B24ME4P55	IC ENGINE COMBUSTION AND POLLUTION
B24ME4P56	HEATING VENTILATION AND AIR CONDITIONING
B24ME4P57	ADDITIVE MANUFACTURING
B24ME4P58	POWDER METALLURGY
B24ME4P59	METAL FORMING AND INJECTION MOULDING

PROGRAMME ELECTIVE VI

B24ME4P61	SIX SIGMA AND QUALITY MANAGEMENT
B24ME4P62	OCCUPATIONAL HEALTH AND SAFETY
B24ME4P63	MEP SYSTEMS AND MANAGEMENT
B24ME4P64	PIPING DESIGN AND MANUFACTURING
B24ME4P65	LOGISTICS AND SUPPLY CHAIN MANAGEMENT
B24ME4P66	BASICS OF PLC PROGRAMMING

OPEN ELECTIVE III

B24ME4G31	FACILITY LOCATION AND PLANNING
B24ME4G32	TOTAL QUALITY MANAGEMENT
B24ME4G33	INTRODUCTION TO INDUSTRY 4.0
B24ME4G34	MAINTENANCE ENGINEERING AND MANAGEMENT
B24ME4G35	NANOTECHNOLOGY AND APPLICATIONS
B24ME4G36	INFORMATION TECHNOLOGY MANAGEMENT

MINOR

Basket I (Design)

SEMESTER	COURSE NO.	COURSE NAME
S3		MECHANICS OF MATERIALS
S4		MECHANICS OF MACHINES
S5		DYNAMICS OF MACHINES
S6		MACHINE DESIGN
S7		DESIGN THINKING AND PRODUCT DEVELOPMENT
S8		MINOR PROJECT*

Basket II (Thermal)

SEMESTER	COURSE NO.	COURSE NAME
S3		FLUID MECHANICS & MACHINERY
S4		THERMODYNAMICS
S5		THERMAL SCIENCE AND ENGINEERING
S6		HEAT TRANSFER
S7		AUTOMOTIVE SYSTEMS
S8		MINOR PROJECT*

Basket III (Production)

SEMESTER	COURSE NO.	COURSE NAME
S3		MATERIAL SCIENCE & TECHNOLOGY
S4		MANUFACTURING PROCESS
S5		PRECISION MANUFACTURING AND MACHINING TECHNOLOGY
S6		INTRODUCTION TO OPERATIONS MANAGEMENT
S7		FUNDAMENTALS OF ROBOTICS AND AUTOMATION
S8		MINOR PROJECT*

HONOURS

Group I (Design)

SEMESTER	COURSE NO.	COURSE NAME
S4		DESIGN OF HYDRAULIC AND PNEUMATIC EQUIPMENTS
S5		DESIGN FOR MANUFACTURING AND ASSEMBLY
S6		ADVANCED THEORY OF MACHINES
S7		TRIBOLOGY
S8		HONORS PROJECT

Group II (Thermal)

SEMESTER	COURSE NO.	COURSE NAME
S4		ADVANCED FLUID MECHANICS
S5		MEASUREMENT METHODS FOR ENGINEERS
S6		SOLAR THERMAL ENGINEERING
S7		AEROSPACE ENGINEERING
S8		HONORS PROJECT

Group III (Production)

SEMESTER	COURSE NO.	COURSE NAME
S4		ADVANCED ENGINEERING MATERIALS
S5		ADVANCED MATERIAL PROCESSING
S6		ADVANCED CHARACTERISATION TECHNIQUES
S7		JIGS AND FIXTURES
S8		HONORS PROJECT

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B.TECH MECHANICAL ENGINEERING

SEMESTER 1

SYLLABUS

B24MA1T01	LINEAR ALGEBRA AND MULTIVARIABLE CALCULUS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analyzing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analyzing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

Prerequisites: Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Solve systems of linear equations, diagonalize matrices and characterise quadratic forms (Cognitive Knowledge level: Apply)
CO 2	Compute the partial and total derivatives and maxima and minima of multivariable functions(Cognitive Knowledge Level : Apply)
CO 3	Compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas. (Cognitive Knowledge Level : Apply)
CO 4	Compute the derivatives and line integrals of vector functions and learn their applications(Cognitive Knowledge Level : Apply)
CO 5	Evaluate surface and volume integrals and learn their inter-relations and applications. (Cognitive Knowledge Level : Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2	1	1	1					1		1
CO 2	3	2	1	1	1					1		1
CO 3	3	2	1	1	1					1		1
CO 4	3	2	1		1							1
CO 5	3	2	1	1	1					1		1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

MODULE 1 (Linear Algebra)

(Text 2: Relevant topics from 7.3, 7.4, 7.5, 8.1,8.3,8.4)

Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and eigenvectors. Diagonalization of matrices, orthogonal transformation, quadratic forms and their canonical forms.

MODULE 2 (Multivariable Calculus-Differentiation)

(Text 1: Relevant topics from sections 13.3, 13.4, 13.5, 13.8)

Partial derivatives, partial derivatives of functions of more than two variables, higher order partial derivatives, differentials and local linearity, The chain rule, Maxima and Minima of functions of two variables, extreme value theorem (without proof), relative extrema.

MODULE 3 ((Multivariable Calculus-Integration))

(Text 1: Relevant topics from sections 14.1, 14.2, 14.3, 14.5, 14.6, 14.8)

Double integrals (Cartesian), reversing the order of integration, Change of coordinates (Cartesian to polar), finding areas using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).

MODULE 4 (Calculus of vector functions)

(Text 1: Relevant topics from sections 12.1, 12.2, 12.6, 13.6, 15.1, 15.2, 15.3)

Vector valued function of single variable, derivative of vector function and geometrical interpretation, motion along a curve-velocity, speed and acceleration. Concept of scalar and vector fields, Gradient and its properties, directional derivative, divergence and curl, Line integrals of vector fields, work as line integral, Conservative vector fields, independence of path and potential function(results without proof).

MODULE 5 (Vector integral theorems)

(Text 1: Relevant topics from sections 15.4, 15.5, 15.6, 15.7, 15.8)

Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals and finding areas. Surface integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z) , Flux integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z), divergence theorem (without proof) and its applications to finding flux integrals, Stokes' theorem (without proof) and its applications to finding line integrals of vector fields and work done.

Text Books

1. H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10^{th} edition, 2015.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} edition, John Wiley & Sons, 2015.

Reference Books

4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9^{th} Edition, Pearson, Reprint,2002.

5. J. Stewart, Essential Calculus, Cengage, 2^{nd} edition, 2017.

6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43^{rd} Edition, 2015.

7. Peter O Neil, Advanced Engineering Mathematics, 7^{th} Edition, Thomson, 2007.

8. Veerarajan T. Engineering Mathematics for first year", Tata McGraw - Hill, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE

No	**Topic**	**No of Lecture/Tutorial Hours**
	Total	45 hours
1	**Linear Algebra**	9
1.1	Systems of linear equations, Solution by Gauss elimination	1
1.2	Row echelon form, finding rank from row echelon form, fundamental theorem for linear systems	2
1.3	Eigen values and eigen vectors	2
1.4	Diagonalization of matrices	2
1.5	Orthogonal transformation, quadratic forms and their canonical forms.	2
2	**Multivariable Calculus - Differentiation**	9
2.1	Partial derivatives	2
2.2	Differentials, Local Linear approximations	2
2.3	Chain rule, total derivative	2
2.4	Maxima and minima	3
3	**Multivariable Calculus - Integration**	9
3.1	Double integrals (Cartesian)-evaluation	2
3.2	Change of order of integration in double integrals, change of coordinates (Cartesian to polar)	2
3.3	Finding areas, mass and centre of gravity of plane laminas	2
3.4	Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates.	3
4	**Calculus of Vector Functions**	9
4.1	Vector valued function of a scalar variable - derivative of vector valued function of scalar variable t-geometrical meaning	2
4.2	Motion along a curve-speed, velocity, acceleration	1
4.3	Gradient and its properties, directional derivative, divergence and curl	3
4.4	Line integrals with respect to arc length, line integrals of vector fields. Work done as line integral	2

4.5	Conservative vector field, independence of path, potential function	1
5	**Vector Integral Theorems**	9
5.1	Green's theorem and it's applications	2
5.2	Surface integrals, flux integral and their evaluation	3
5.3	Divergence theorem and applications	2
5.4	Stokes theorem and applications	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1): Solve systems of linear equations, diagonalize matrices and characterise quadratic forms.

1. A is a real matrix of order 3×3 and $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$. What can you say about the solution of $AX = 0$ if rank of A is 2 ? 3 ?
2. Given A $= \begin{bmatrix} 3 & 0 & 2 \\ 0 & 2 & 0 \\ -2 & 0 & 0 \end{bmatrix}$, find an orthogonal matrix P that diagonalizes A.
3. The matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$ has an eigenvalue 5 with corresponding eigenvector $X = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$. Find A^5X.

Course Outcome 2 (CO 2): Compute the partial and total derivatives and maxima and minima of multivariable functions.

1. Find the slope of the surface $z = x^2y + 5y^3$ in the x-direction at the point $(1, -2)$.
2. Given the function $w = xy + z$, use the chain rule to find the instantaneous rate of change of w at each point along the curve $x = \cos t$, $y = \sin t$, $z = t$.
3. Determine the dimension of rectangular box open at the top, having a volume 32 cubic ft and requiring the least amount of material for it's construction.

Course Outcome 3 (CO 3): Compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas.

1. Evaluate $\iint_D (x+2y)\, dA$ where D is the region bounded by the parabolas

   $y = 2x^2$ and $y = 1 + x^2$.

2. Explain how you would find the volume under the surface $z = f(x, y)$ and over a specific region D in the xy plane using triple integral?

3. Find the mass and centre of gravity of a triangular lamina with vertices (0,0), (2,1), (0,3) if the density function is $f(x, y) = x + y$.

Course Outcome 4 (CO 4): Compute the derivatives and line integrals of vector functions and learn their applications

1. How would you calculate the speed, velocity and acceleration at any instant of a particle moving in space whose position vector at time t is $\mathbf{r}(t)$?

2. Find the work done by the force field $\mathbf{F} = (e^x - y^3)\ \mathbf{i} + (\cos y + x^3)\ \mathbf{j}$ on a particle that travels once around the unit circle centered at origin having radius 1.

3. When do you say that a vector field is conservative? What are the implications if a vector field is conservative?

Course Outcome 5 (CO 5): Evaluate surface and volume integrals and learn their inter-relations and applications

1. Write any one application each of line integral, double integral and surface integral.

2. Use the divergence theorem to find the outward flux of the vector field $\mathbf{F}(x, y, z) = z\mathbf{k}$ across $x^2 + y^2 + z^2 = a^2$.

3. State Greens theorem. Use Green's theorem to express the area of a plane region bounded by a curve as a line integral.

MODEL QUESTION PAPER

QP CODE: **Pages: 3**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24MA1T01

Course Name: LINEAR ALGEBRA AND MULTIVARIABLE CALCULUS

Common to all branches

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Determine the rank of the matrix $\begin{bmatrix} 1 & 2 & -1 \\ -2 & -4 & 2 \\ 3 & 6 & -3 \end{bmatrix}$
2. Write down the eigen values of A = $\begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}$
3. Find $f_x(1,3)$ and $f_y(1,3)$ for the function $f(x, y) = 2x^3y^2 + 2y + 4x$.
4. Show that the function $u(x, t) = sin(x-ct)$ is a solution of the equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$.
5. Use double integral to find the area of the region enclosed between the parabola $y = \frac{x^2}{2}$ and the line $y = 2x$.
6. Use polar coordinates to evaluate the area of the region bounded by $x^2 + y^2 = 4$, the line y = x and the y axis in the first quadrant.
7. Is the vector $\mathbf{r}$ where $\mathbf{r} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ conservative. Justify your answer.
8. Find a unit vector normal to the surface $x^3 + y^3 + 3xyz = 3$ at the point (1,2,-1).
9. What is the outward flux of $\mathbf{F}(x, y, z) = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ across any unit cube.
10. What is the relationship between Green's theorem and Stokes theorem?

PART B

Answer any one question from each module. Each question carries 14 marks.

11. (a) Solve the following system of equations
y + z - 2w = 0
2x - 3y - 3z + 6w = 2
4x + y + z - 2w = 4 7

(b) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} 2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & 2 & 0 \end{bmatrix}$ 7

OR

12. (a) Diagonalize the matrix $\begin{bmatrix} -1 & 2 & -2 \\ 2 & 4 & 1 \\ 2 & 4 & 1 \end{bmatrix}$ 7

(b) What kind of conic section the quadratic form $3x^2 + 22xy + 3y^2 = 0$ represents? Transform it to principal axes. 7

13. (a) Find the local linear approximation to $f(x, y) = \sqrt{x^2 + y^2}$ at the point (3,4). Use it to approximate $f(3.04, 3.98)$. 7

(b) Let $w = \sqrt{x^2 + y^2 + z^2}$, x = cos$\theta$, y = sin$\theta$, z = tan$\theta$. Use chain rule to find $\frac{dw}{d\theta}$ when $\theta = \frac{\pi}{4}$ 7

OR

14. (a) Let $z = f(x, y)$ where $x = rcos\theta$, $y = rsin\theta$, prove that

$$\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2}\left(\frac{\partial r}{\partial \theta}\right)^2$$

7

(b) Locate all relative maxima, relative minima and saddle points of $f(x, y) = xy + \frac{a^3}{x} + \frac{b^3}{y}$,$(a \neq 0, b \neq 0)$. 7

15. (a) Evaluate $\iint\limits_D (2x^2y + 9y^3)\,dx\,dy$ where D is the region bounded by $y = \frac{2}{3}x$ and $y = 2\sqrt{x}$.

(b) Evaluate $\int_0^4 \int_{\sqrt{y}}^2 e^{x^3}\,dx\,dy$ by changing the order of integration. 7

OR

16. (a) Find the volume of the solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ and $z = 0$. 7

(b) Evaluate $\iiint \sqrt{1 - x^2 - y^2 - z^2}\,dx\,dy\,dz$, taken throughout the volume of the sphere $x^2 + y^2 + z^2 = 1$ 7

17. (a) Prove that the force field $\mathbf{F} = e^y\mathbf{i} + xe^y\mathbf{j}$ is conservative in the entire xy-plane. 7

(b) Find the work done in moving a particle along a straight line from (0,0,0) to (2,1,3) by the force $\mathbf{F} = 3x^2\mathbf{i} + (2xz - y)\mathbf{j} + z\mathbf{k}$ 7

OR

18. (a) Find the divergence of the vector field $\mathbf{F} = x^3y^2z\mathbf{i} + xyz^3\mathbf{j} + xyz^2\mathbf{k}$ at (1,1,1). 7

(b) Find the work done by the force field $\mathbf{F}$(x, y, z) = xy$\mathbf{i}$ + yz$\mathbf{j}$ + xz$\mathbf{k}$ along C where C is the curve $\mathbf{r}(t) = t\mathbf{i} + t^2\mathbf{j} + t^3\mathbf{k}$. 7

19. (a) Use divergence theorem to find the outward flux of the vector field $\mathbf{F} = 2x\mathbf{i} + 3y\mathbf{j} + z^3\mathbf{k}$ across the unit cube bounded by x = 0, y = 0, z = 0, x =1, y = 1, z = 1. 7

(b) Find the circulation of $\mathbf{F}$ = (x − z)$\mathbf{i}$ + (y − x)$\mathbf{j}$ + (z − xy)$\mathbf{k}$ using Stokes theorem around the triangle with vertices A(1,0,0), B(0,2,0) and C(0,0,1). 7

OR

20. (a) Use divergence theorem to find the volume of the cylindrical solid bounded by $x^2 + 4x + y^2 = 7$, $z = -1$, $z = 4$ given the vector field $\mathbf{F} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ across surface of the cylinder. 7

(b) Use Stokes theorem to evaluate $\int_c F.dr$ where $\mathbf{F} = x^2\mathbf{i} + 3x\mathbf{j} - y^3\mathbf{k}$ where C is the circle $x^2 + y^2 = 1$ in the xy-plane with counterclockwise orientation looking down the positive z-axis. 7

B24ES1T01B	PROBLEM SOLVING AND PROGRAMMING TECHNIQUES (B)	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble

This course shall prepare the student to write efficient and robust Python programs for solving computational problems. Through a combination of theoretical concepts and practical applications, students will explore the fundamentals of Python programming, including data types, control structures, and functions. The course will also cover essential libraries and frameworks used in engineering applications, emphasizing best practices in coding. By the end of the course, students will be equipped with the skills needed to implement algorithms, and develop programs meet engineering standards.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Understand fundamental computing concepts, including algorithms, pseudocode, flowcharts, and algorithmic problem-solving techniques. (Cognitive Knowledge Level: Apply)
CO 2	Develop proficiency in using Python's data structures, control flow statements, and loops to effectively manage and manipulate data. (Cognitive Knowledge Level: Apply)
CO 3	Acquire skills in defining and calling functions, using modules and packages, and working with Python's standard libraries to create modular and efficient code (Cognitive Knowledge Level: Apply)
CO 4	Learn file handling techniques in Python (Cognitive Knowledge Level: Apply)
CO 5	Utilize Python for mathematical computations and understand its role in data analysis. (Cognitive Knowledge Level: Analyse)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3									1
CO 2	3	3	3									1
CO 3	3	3	3									1
CO 4	3	3	3									1
CO 5	3	3	3	3	2							1

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember			
Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part

B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (6 hours)

Introduction to programming languages : low level & high level, compiler, assembler, and interpreter.
Fundamentals of computing – Algorithms, pseudocode, flowchart, algorithmic problem solving.
Introduction to Python, brief history of Python, installing Python, IDE, Python coding introduction, keywords and Identifiers, Python statements, comments in Python, getting user input, variables, data types, numbers, strings, Python operators, precedence of operators.

MODULE 2 (8 hours)

Data Structures - Lists, Tuples, Dictionary.
Control flow and Operators Control flow and syntax, if statement, if-else statement, nested conditionals, logical operators, Loop in Python - while Loop, break and continue, for loop, pass statement

MODULE 3 (7 hours)

Function in Python - introduction of function, defining and calling a function, function arguments, built in function, scope of variables.
Modules and Packages – creating custom modules, importing modules, standard modules-sys, os, datetime, math, random, introducing Python packages – numpy, pandas, matplotlib.

MODULE 4 (5 hours)

File handling - files, and directories, modes for opening a file, reading data from a file, writing data to a file, saving a file, deleting an existing file, try and except, navigating directories using os and pathlib, creating and removing directories

MODULE 5 (10 hours)

Data analysis - overview of numpy and pandas, numpy – array creation, special arrays, indexing, slicing, reshaping, flattening, concatenation, splitting, using numpy for mathematical computations - element wise addition, subtraction, multiplication, division, statistical operations - mean, median, variance, standard deviation, matrix multiplication, basic functions - sin, cos, tan, exp, power, log, sum, product, min, max, broadcasting, logical operators, creating dataframes – from csv/txt file, data frame manipulation - indexing, selecting, filtering, saving a dataframe as csv/txt file, line plot and scatter plot using matplotlib, customizing plots.

Text Books

1. Allen B Downey, "Think Python", O'Reilly.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython", Shroff/O'Reilly.

Reference Books

1. Charles Dierbach, "Introduction to Computer Science using Python", Wiley.
2. Yashavant Kanetkar, "Let Us Python", BPB Publications.
3. edX MOOC Course, "CS50 Introduction to Programming with Python".

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Total Hours	36 Hours
	Module 1	6
1.1	Introduction to programming languages – low level & high level, compiler, assembler, and interpreter.	1
1.2	Fundamentals of computing – Algorithms, pseudo code, flow chart, algorithmic problem solving.	2
1.3	Introduction to Python, brief history of Python, installing Python, IDE.	1
1.4	Python coding introduction, keywords and Identifiers, Python statements, comments in Python.	1
1.5	Getting user input, variables, data types, numbers, strings, Python operators, precedence of operators.	1
	Module 2	8
2.1	Data Structures - Lists, Tuples, Dictionary.	2
2.2	Control flow and Operators Control flow and syntax, if statement, if-else statement, nested conditionals, logical operators.	2
2.3	Loop in Python - while Loop, break and continue.	2
2.4	For loop, pass statement.	2
	Module 3	7
3.1	Function in Python - introduction of function, defining and calling a function, function arguments	2
3.2	Built in function, scope of variables.	1

3.3	Modules and Packages – creating custom modules, Importing Modules, standard modules- sys, os, datetime, math, random.	2
3.4	Introducing Python packages – numpy, pandas, matplotlib.	2
	Module 4	5
4.1	File handling - files, and directories	1
4.2	Modes for opening a file, reading data from a file, writing data to a file, saving a file, deleting an existing file, try and except.	2
4.3	Navigating directories using os and pathlib, creating and removing directories.	2
	Module 5:	10
5.1	Data analysis - overview of numpy and pandas .	1
5.2	Numpy – array creation, special arrays, indexing, slicing, reshaping, flattening, concatenation, splitting.	2
5.3	Numpy for mathematical computations - element wise addition, subtraction, multiplication, division.	2
5.4	Statistical operations - mean, median, variance, standard deviation, matrix multiplication.	1
5.5	Basic functions - sin, cos, tan, exp, power, log, sum, product, min, max, broadcasting.	1
5.6	Logical operators.	1
5.7	Creating dataframes – from csv/txt file, data frame manipulation - indexing, selecting, filtering, saving a dataframe as csv/txt file, line plot and scatter plot using matplotlib, customizing plots.	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Discuss about pseudocode, algorithm, and a flow chart. What is the importance of writing an algorithm before writing the actual program?
2. Draw a flow chart to check if a given number is an Armstrong number.

Course Outcome 2 (CO 2):

1. Write a Python program that determines whether a given year is a leap year. Explain the logic used to make this determination
2. Write a Python program to calculate the factorial of a number using either a for loop or a while loop. Discuss why you chose the specific type of loop for this task.

Course Outcome 3 (CO 3):

1. How do Python modules and libraries simplify programming tasks? Provide examples of using a standard library to perform file handling operations.

2. Write a Python program to calculate the tax for an Indian citizen using both the old and new tax regimes. Utilize appropriate Python modules, libraries, and functions to structure your program.

Course Outcome 4 (CO 4):

1. How would you write a Python script to read data from a text file, process the data to remove any blank lines, and save the cleaned data to a new file?

2. How to check if a file exists in a particular directory? Give an error message if it doesn't exists.

Course Outcome 5 (CO 5):

1. How would you use NumPy to create an array of 10 random numbers and then convert it into a Pandas DataFrame?

2. Given a CSV file containing numerical data, explain how you would use NumPy and Pandas to calculate the mean and standard deviation of a specific column.

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24ES1T01B

Course Name: PROBLEM SOLVING AND PROGRAMMING TECHNIQUES(B)

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. What is the main difference between a compiler and an interpreter?
2. What is the difference between a high-level programming language and a low-level programming language?
3. What is the main difference between a list and a tuple in Python?
4. How does a for loop differ from a while loop in Python?
5. What is the scope of a variable in Python?
6. How can you import a specific function from a module in Python?
7. How can you list all files in a directory using Python?
8. Discuss the various modes for opening a file?
9. How do you create a NumPy array with random integers between 1 and 10?
10. What is the primary purpose of the pandas library in Python?

PART B

Answer any one question from each module. Each question carries 14 marks.

11. Compare and contrast high level and low level programming languages. Discuss the advantages and disadvantages of each with examples and explain how a compiler, interpreter and assembler play a role in executing programs written in these languages.

OR

12. Describe the steps involved in solving a problem using an algorithmic approach. Write an algorithm to find the maximum number in a list, present it using both pseudocode and a flowchart. Write a code for the same in Python.

13. Explain the key differences between lists, tuples, and dictionaries in Python. Provide examples of scenarios where each data structure would be most appropriately used, and discuss how their unique properties affect performance and usability in a program.

OR

14. Discuss the control flow mechanisms in Python, including conditional statements and loops. Explain the role of logical operators within control flow, and demonstrate using a Python program how they can be used to find the factorial of a number.

15. Explain the concept of functions in Python, including the use of arguments and return values. Illustrate with examples how defining and calling functions can improve code organization and reusability, and discuss the importance of variable scope in function design.

OR

16. Describe how modules and packages are used in Python to manage code complexity. Explain the process of creating a custom module and importing standard libraries. Write a Python program to create an array of random numbers in the range 1 to 100 and find its mean, median and standard deviation by defining a function. You can use the standard libraries of Python.

17. Explain the process of reading from and writing to files in Python. Discuss the different modes of file access. Provide an example of a program that reads the names of 30 students and total marks scored from a user and save the data to a file after the entry is complete.

OR

18. Write a Python program to read the contents of file, replace a particular name in the file with another one and save the updated contents as a new file.

19. Describe the role of NumPy in data analysis. Explain how NumPy arrays differ from Python lists and demonstrate how NumPy can be used to perform efficient mathematical operations on large datasets.

OR

20. Explain how the pandas library is used for data manipulation and analysis in Python. Provide an example of loading a dataset into a pandas DataFrame, performing filtering, and discuss how pandas simplifies data analysis tasks.

B24ES1T07	FUNDAMENTALS OF ELECTRICAL ENGINEERING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble

This course aims to provide the student with an understanding of the fundamental concepts of electrical circuits, DC and AC machines. It gives an overall concept about the fundamental principles of electric circuits, constructional details and characteristics of electrical machines. The course equips the students to apply the acquired knowledge to analyse the electric circuits, DC and AC electric machines.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Understand the fundamental concepts of electric circuits and apply circuit laws to solve basic DC electric circuits. (Cognitive Knowledge Level: Apply)
CO 2	Analyse the characteristics of DC machines and select appropriate machines for different applications. (Cognitive Knowledge Level: Analyse)
CO 3	Understand the fundamental concepts of AC systems and analyse single-phase AC circuits with series combinations of R, L, and C. (Cognitive Knowledge Level: Analyse)
CO 4	Explain the working of transformers and induction motors and identify their applications. (Cognitive Knowledge Level: Apply)
CO 5	Describe the operation of alternators and BLDC motors and their applications. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	2		2	1		1	1	1	1
CO 2	3	2	2	1		2	1		1	1	1	1
CO 3	3	3	2	2		3	1		1	1	1	1
CO 4	3	2	2	1		3	1		1	1	1	1
CO 5	3	2	2	1		3	2		1	1	1	1

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember	20	20	20
Understand	20	20	20
Apply	20	40	30
Analyse	40	20	30
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance 10 marks
Continuous Assessment Test (2 numbers) 25 marks
Assignment/Quiz/Course Project 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (5 hours)

Introduction to Electrical Systems: Basic Terminology including Electric circuit, Voltage, Current, Power, Energy, Resistance, Inductance and Capacitance.

Analysis of DC electric circuits: Resistances in Series and Parallel combination – Current and Voltage division rules, Ohm's Law, Kirchoff's L aws. S olution of E lectrical circuits using Mesh analysis

MODULE 2 (8 hours)

DC Generator: Construction, Working of a DC Generator, types of Armature windings, EMF equation, Types of DC Generators, Losses, Condition for maximum efficiency, Power flow d iagram, Efficiency, Arm ature rea ction (Co ncept onl y), Applications.

DC Motors: Principle of operation, Back emf, Necessity of Starters, Speed and Torque equation, Types of DC motor, Speed- Torque characteristics of Shunt and Series motors, Losses, Applications.

MODULE 3 (8 hours)

AC Fundamentals: Faraday's Laws of Electromagnetic Induction, Lenz's Law, Self-Inductance and Mutual inductance, Coefficient of coupling. (Concept and equations only). Generation of Alternating Voltages and Waveform, Frequency, Period, Average, RMS values, Form factor and Peak factor of Sine wave forms only. Phasor representation of sinusoidal quantities, Lagging and Leading Concepts. Rectangular and Polar representation of Phasors.
Analysis of Series RL, RC and RLC circuits with introduction to Power, Power factor, Active Power, Reactive Power and Apparent Power. Generation of Three Phase AC, Phase sequence, Comparison between Three phase and Single Phase, Line and Phase Values of Current and Voltage in Star and Delta connections.

MODULE 4 (9 hours)

Transformers: Types based on Construction, Principle of operation, EMF equation, Ideal Transformer, Losses, Efficiency, Condition for Maximum efficiency, Transformer ratings, Applications.
Three phase Induction motor: Construction, Classification, Rotating Magnetic Field, Principle of operation, Torque equation, Torque- Slip characteristics, Need of Starter, Starting using a Star Delta starter, Speed Control and Braking in Induction motors, Applications. Single phase Induction motors, Different types, Applications.

MODULE 5 (6 hours)

Three Phase Alternators: Construction details, Classification based on construction, Principle of operation, emf equation, Voltage regulation by direct method, Necessary conditions for the Parallel operation of Alternators, Applications.
BLDC motor: Construction, Principle of operation, Applications.

Text Books

1. B. L. Theraja, A. K. Theraja, Textbook of "Electrical Technology" Volume 1, S. Chand & Co., 2005.

2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", 3rd Edition, Tata McGraw Hill, 2010.

3. V. K. Mehta & Rohit Mehta, "Principles of Electrical Engineering", S Chand Publishing, 2003.

4. J. B. Gupta, "Theory and Performance of Electrical Machines", S.K. Kataria & Sons, 2007.

5. R. K. Rajput, "Basic Electrical Engineering", Laxmi Publications, 2009.

6. D C Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, 2010.

Reference Books

1. C. L. Wadhwa, "Basic Electrical Engineering", New Age International Publisher, 2007.

2. S. K. Bhattacharya, "Basic Electrical and Electronics Engineering", Pearson Education India, 2011.

3. Del Toro V, “Electrical Engineering Fundamentals”, Pearson Education, 2015.

4. A. Sudhakar, Shyammohan S.,“Circuits and Networks: Analysis and Synthesis “by McGraw-Hill, 2017.

5. Hayt W H, Kemmerly J E, and Durbin S M, “Engineering Circuit Analysis”, Tata McGraw-Hill, 2013.

6. Hughes, “Electrical and Electronic Technology”, Pearson Education, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No	{Topic	**No of Lecture/Tutorial Hours**
	Module 1	**5**
1.1	**Introduction to Electrical Systems:** Basic Terminology including Electric circuit, Voltage, Current, Power, Energy, Resistance, Inductance and Capacitance.	1
1.2	**Analysis of DC electric circuits:** Resistances in Series and Parallel combination – Current and Voltage division rules, Ohm’s Law, Kirchoff’s Laws. Solution of Electrical circuits using Mesh analysis. Numerical problems.	4
	Module 2	**8**
2.1	**DC Generator:** Construction, Working of a DC Generator, types of Armature windings.	1
2.2	EMF equation, Types of DC Generators, Losses, Condition for maximum efficiency, Power flow diagram, Efficiency, Armature reaction (Concept only), Applications. Numerical Problems	4
2.3	**DC Motors:** Principle of operation, Back emf, Necessity of Starters. Speed and Torque equation, Types of dc motor, Speed- Torque characteristics of Shunt and Series motors, Losses, Applications. Numerical Problems	3
	Module 3	**8**

3.1	**AC Fundamentals:** Faraday's Laws of Electromagnetic Induction, Lenz's Law, Self-Inductance and Mutual inductance, Coefficient of coupling. (Concept and equations only).	1
3.2	Generation of Alternating Voltages and Wave form, Frequency, Period, Average and RMS values, Form factor and peak factor of Sine wave forms only. Phasor representation of sinusoidal quantities, Lagging and Leading Concepts. Rectangular and Polar representation of Phasors. Numerical problems	3
3.3	Analysis of Series RL, RC and RLC circuits with introduction to Power, Power factor, Active Power, Reactive Power and Apparent Power. Generation of Three Phase AC, Phase sequence, Comparison between Three phase and Single Phase, Line and Phase Values of Current and Voltage in Star and Delta connections. Numerical problems	4
	Module 4	**9**
4.1	**Transformers:** Types based on Construction, Principle of operation, EMF equation, Ideal Transformer, Losses, Efficiency, Condition for Maximum efficiency, Transformer ratings, Applications. Numerical problems	3
4.2	**Three phase Induction motor:** Construction, Classification, Rotating Magnetic Field, Principle of operation.	2
4.3	Torque equation, Torque- Slip characteristics, Need of Starter, Starting using a Star Delta starter, Speed Control and Braking in Induction motors, Applications. Single phase Induction motors, Different types, Applications. Numerical problems	4
	Module 5	**6**
5.1	**Three Phase Alternators:** Construction details, Classification based on construction, Principle of operation, emf equation, Voltage regulation by direct method, Necessary conditions for the Parallel operation of Alternators, Applications. Numerical problems	5
5.2	**BLDC motor:** Construction, Principle of operation, Applications.	1
	Total Hours	**36 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Define the terms such as Voltage, Current, Power etc

2. Solve problems based on series/parallel network reduction method and current/Voltage division rule

3. Solve problems with Mesh analysis.

Course Outcome 2 (CO 2):

1. Describe the construction and Principle of working of DC Generator/Motor

2. Explain different types of DC Generator/Motor and its applications.

3. Problems on emf induced, speed, Torque etc

Course Outcome 3 (CO 3):

1. Explain Faraday's laws of Electromagnetic Induction, self-inductance, mutual inductance and coefficient of coupling etc.

2. Problems on rms and average values of sinusoidal waveforms

3. Analyze Series RL, RC, RLC ac circuits, Develop the relation between Line and Phase values of voltage and current in Star and Delta connections.

Course Outcome 4 (CO 4):

1. Describe the construction, principle of Operation of Transformers.

2. Problems on emf equation and efficiency of Transformer

3. Describe the construction and working of of Three phase Induction motor and its applications.

4. Explain a single-phase Induction motor and its applications.

Course Outcome 5 (CO 5):

1. Explain the construction, working principle and classifications of an Alternator.

2. Problems on the emf equation, Voltage regulation by direct method.

3. Explain the construction and working of BLDC motor.

MODEL QUESTION PAPER

QP CODE: **Pages: 3**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24ES1T07

Course Name: FUNDAMENTALS OF ELECTRICAL ENGINEERING

Max. Marks: 100 Duration: 3 hours

PART A

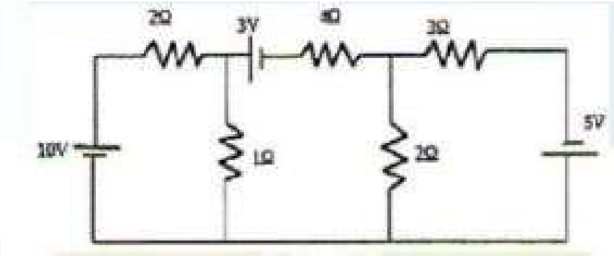
Answer all questions. Each question carries 3 marks.

1. Derive an expression for the energy stored in an inductor
2. Two coils connected in parallel across 100V supply mains take 10A from the line. The power dissipated in one coil is 600W. What is the resistance of the other coil?
3. Explain the necessity of starters in dc motors
4. Calculate the emf generated by 4 pole wave wound with 65 slots and 12 conductors/pole when driven at 1200rpm. Flux per pole is 0.02wb.
5. Define the following (a) cycle (b) time period (c) average value (d) rms value (e) peak factor (f) form factor.
6. State Faradays law of Electromagnetic Induction.
7. Derive the emf equation for a single-phase transformer
8. What is the effect of supply voltage on the torque of an induction motor?
9. What are the necessary conditions for parallel operation of an alternator?
10. List out the applications of BLDC motors.

PART B

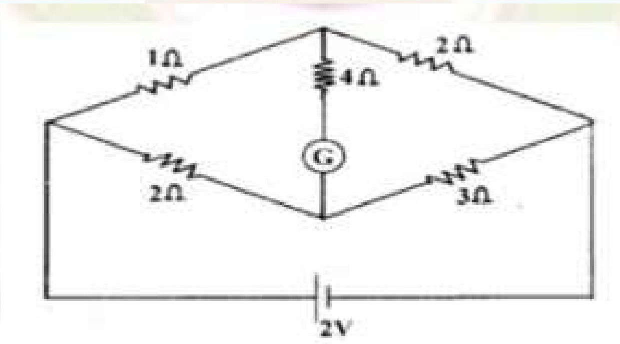
Answer any one question from each module. Each question carries 14 marks.

11. Calculate the node voltage in the circuit shown, applying node analysis



OR

12. State and explain Kirchhoff's laws. Calculate the current through the galvanometer G in the circuit shown



13. A 250V, 4 pole series motor has a two-circuit wave wound winding with 105 slots, each consisting of 12 conductors. The gap flux per pole is 0.02 wb when motor is on full load and taking a current of 45A. The armature and field resistances are 0.2Ω and 0.1Ω respectively. The iron and frictional losses are 700W. Calculate the (a) speed (b) shaft torque (c) bhp

OR

14. Two dc shunt generators with induced emfs of 120V and 115V, armature resistance of 0.05Ω and field resistances of 20Ω and 25Ω are in parallel suppling a total load of 25Kw. Calculate the load shared by each generator

15. Differentiate between statically and dynamically induced emf. A conductor of length 0.5m moves in uniform magnetic field of flux density 1.1T at a velocity of 30m/s. Calculate the emf induced in the conductor if the direction of motion of the conductor is inclined at an angle 60 to the direction of field.

OR

16. Derive the average value, rms value, amplitude factor and formfactor of a purely sinusoidal waveform.

17. A three phase, 50Hz induction motor has starting torque which is 1.25 times full load torque and a maximum torque which is 2.5 times full load torque. Neglecting stator resistance and rotational losses and assuming constant rotor resistance, find (i) the slip at full load (ii) slip at maximum torque and (iii) the rotor current at starting in per unit of full load rotor current.

OR

18. The primary and secondary windings of a 500Kva single phase transformer have resistance of 0.4Ω and 0.0015Ω. The primary and secondary voltages are 6000V and 400V and the iron loss is 3.2Kw. Calculate the efficiency on (a) full load (b) half load

19. With neat diagram, explain the construction and principle of operation of BLDC motors

OR

20. Discuss the constructional details of three phase alternators and classify them.

<table>
<tr><td rowspan="2">B24ES1T05B</td><td rowspan="2">BASIC CIVIL AND MECHANICAL ENGINEERING (B)</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td><td>4</td><td>2024</td></tr>
</table>

Preamble

In pursuit of advancing knowledge and fostering a holistic understanding of engineering disciplines, this course on Basic Civil and Mechanical Engineering endeavors to provide students of Mechanical Engineering with a comprehensive insight into the fundamentals of both Civil and Mechanical Engineering. It seeks to empower students with the knowledge and skills necessary to contribute meaningfully to the advancement and innovation of Civil and Mechanical engineering practices, thereby meeting the evolving needs of society.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering.(Cognitive Knowledge Level: Understand)
CO 2	Discuss the Materials, energy systems, water management and environment for green buildings. (Cognitive Knowledge Level: Apply)
CO 3	Explain different types of buildings, building components, building materials and building construction. (Cognitive Knowledge Level: Apply)
CO 4	Understand the basic Thermodynamic concepts and Illustrate the working of IC engines.(Cognitive Knowledge Level: Understand)
CO 5	Understand the basic principle of power transmission elements and material handling devices. (Cognitive Knowledge Level: Understand)
CO 6	Describe the fundamentals of Refrigeration and air conditioning systems and basic knowledge on manufacturing and metal joining processes. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1		1			3	2	2				2
CO 2	3	1	1		2	2	3					2
CO 3	3	2			2	1	1	1				2
CO 4	3	1	1				1			1		1
CO 5	3	1	2			1				1		1
CO 6	2	1	1			1	1			1		1

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

For the end semester examination, there will be two parts: Part I – Basic Civil Engineering and Part II – Basic Mechanical Engineering. Part I and PART II carries 50 marks each. Part I contain 2 parts - Part A and Part B. Part A contain 5 questions carrying 4 marks each (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have maximum 2 sub-divisions. The pattern for end semester examination for part II is same as that of part I. **The student should answer both part I and part 2 in separate answer booklets.**

SYLLABUS
PART I– Basic Civil Engineering

MODULE 1 (9 hours)

Introduction to Civil Engineering : Relevance of Civil Engineering in the overall infrastructural development of the country, Brief introduction to major disciplines of Civil Engineering
Conventional construction materials : Types, properties and uses of building materials: bricks, stones, cement, sand, timber and steel. Cement concrete: Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC), Constituent materials and properties (brief discussion only).
Other construction materials: Glass, Ceramics, Plastics, Composite materials, Thermal and acoustic insulating materials, Decorative panels, water proofing materials, Gypsum.
Surveying: Basic Principles of surveying, instruments, methods and measurements.
Environment :Water Supply and Sanitary Systems, Urban Air Pollution Management, Solid Waste Management, Urban Flood Control (brief discussion only).

MODULE 2 (8 hours)

Components of a building: **Sub-structure** :Foundation- types of foundations- Shallow and deep, Machine foundation.
Super structure : Masonry: Brick masonry- Header and stretcher bond, English bond & Flemish bond-plan, elevation and isometric view, Stone masonry, Rubble masonry and Ashlar masonry.
Roof: Functions, types, and materials– flat roof, pitched roof, Shells and folded plates, Roof coverings for pitched roof-Thatch, Shingle, Tiles, Slates, Aluminium sheets, Galvanised iron (G.I.) sheets, Sandwich roof panels, roofing for industrial buildings.
Flooring: Functions, types of flooring - Mud, Brick, Flag stone, Cement concrete, Terrazzo, Mosaic, Marble, Tiles, Timber, Rubber, P.V.C.
Types of structures : Framed structures and load bearing wall structures. Pre-fabricated, pre-cast and modular construction. (brief discussion only).

MODULE 3 (6 hours)

Type of buildings : Classification of buildings based on occupancy as per NBC
Building area: : Plinth area, built-up area, floor area, carpet area and floor area ratio for a building as per KMBR
Building rules and regulations: Relevance of NBC, KMBR & CRZ norms (brief discussion only), Selection of site-Site plan preparation for buildings as per Kerala Municipal Building Rules, general provisions regarding site and building requirements.
Green buildings: Materials, energy systems, water management and environments for green buildings. (brief discussions only)

PART II– Basic Mechanical Engineering

MODULE 4 (8 hours)

Basics of thermodynamics: State, Process, Cycle, System and control volume concept, Enthalpy and Entropy, Types of thermodynamic processes, thermodynamic laws, Carnot, Otto and Diesel cycles, Efficiency, Heat addition and rejection, Problems
I.C Engines: Working of SI and CI engine, Two stroke and Four stroke engine, IC engine parts, Fuel, Cooling and Lubrication systems, CRDI and MPFI engines. Concept of hybrid engines.

MODULE 5 (7 hours)

Power Transmission Elements Classification and applications of mechanical drives, Velocity ratio of belt drive, Length of belt, Slip in belt, Power transmitted. Gear drive: Types, Gear Ratio, Simple, compound and epicyclic gear trains (simple descriptions only)
Automotive Drives: Manual Transmission, Automatic Manual Transmission (AMT), Continuous Variable Transmission (CVT), Torque converter.

MODULE 6 (8 hours)

Refrigeration : Basic terminologies, Vapour Compression Refrigeration system with PH and TS diagram, Air conditioning- Summer and winter air conditioning, Unitary and central air conditioning system, Inverter technology.
Basic description of the manufacturing processes: (Basic Concepts only and examples of products) – Die Casting, Forging, Rolling, Extrusion. Basic description of Lathe and Drilling Machine, Lathe operations. Basic description of Metal Joining Processes: Arc and gas Welding, Soldering and Brazing, their applications

Text Books

1. S. C. Rangwala, "Civil Engg. Drawing", Charotar Pub. House Anand.
2. B. C. Punamia, "Surveying Vol .I & II", Laxmi Publication Delhi.

3. J. Benjamin, “Basic Mechanical Engineering”, Pentex Books, 9th Edition, 2018

4. P. Balachandran, Basic Mechanical Engineering, Owl Books

Reference Books

1. R. Chudley, “Construction Technology Vol. I to IV”, Longman Group, England (2011).

2. R. Chudley and R. Greeno, “Building Construction Handbook”, Addison Wesley, Longman Group, England (1998).

3. M. S. Mamlouk, and J. P. Zaniewski, “Materials for Civil and Construction Engineering”, Pearson Publishers (2011)

4. W.B. McKay and J.K. McKay, “Building Construction Vol. 1 to 4”, Pearson India Education Services. (2013)

5. S. C. Rangwala and K.B. Dalal, Building Construction, Charotar Publishing House (2017).

6. Kerala Municipal Building Rules (latest revision)

7. M. Clifford, K. Simmons, “An Introduction to Mechanical Engineering Part I”, CRC Press

8. Roy and Choudhary, “Elements of Mechanical Engineering”, Media Promoters &Publishers Pvt. Ltd., Mumbai.

9. G. S. Sawhney, “Fundamentals of Mechanical Engineering”, PHI

10. M.S. Shanmugam, Palanichamy, “Basic Civil and Mechanical Engineering”, McGraw Hill Education; First edition, 2018

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Module 1	**9**
1.1	Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country, Brief introduction to major disciplines of Civil Engineering .	2

1.2	Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand, timber and Steel. Cement concrete: Plain Cement Concrete (PCC) and Reinforced Cement Concrete (RCC), Constituent materials and properties (brief discussion only).	2
1.3	Other construction materials: Glass, Ceramics, Plastics, Composite materials, Thermal and acoustic insulating materials, Decorative panels, water proofing materials, Gypsum .	2
1.4	Surveying: Basic Principles of surveying, instruments, methods and measurements	1
1.5	Environment: Water Supply and Sanitary Systems, Urban Air Pollution Management, Solid Waste Management, Urban Flood Control (brief discussion only).	2
	Module 2	**8**
2.1	Components of a building: Sub-structure: Foundation-types of foundations- Shallow and deep, Machine foundation .	2
2.2	Super structure: Masonry: Brick masonry- Header and stretcher bond, English bond & Flemish bond-plan, elevation and isometric view, Stone masonry, Rubble masonry and Ashlar masonry.	2
2.3	Roof: Functions, types and materials– flat roof, pitched roof, Shells and folded plates, Roof coverings for pitched roof-Thatch, Shingle, Tiles, Slates, Aluminium sheets, Galvanised iron (G.I.) sheets, Sandwich roof panels, roofing for industrial buildings.	2
2.4	Flooring: Functions, types of flooring - Mud, Brick, Flag stone, Cement concrete, Terrazzo, Mosaic, Marble, Tiles, Timber, Rubber, P.V.C.	1
2.5	Types of structures: Framed structures and load bearing wall structures. Pre-fabricated, pre-cast and modular construction. (brief discussion only).	1
	Module 3	**6**
3.1	Type of buildings: Classification of buildings based on occupancy as per NBC.	1
3.2	Building area: Plinth area, built-up area, floor area, carpet area and floor area ratio for a building as per KMBR.	2
3.3	Building rules and regulations: Relevance of NBC, KMBR & CRZ norms (brief discussion only), Selection of site-Site plan preparation for buildings as per Kerala Municipal Building Rules, general provisions regarding site and building requirements.	2
3.4	Green buildings: Materials, energy systems, water management and environments for green buildings.(brief discussions only)	1
	Module 4	**8**

4.1	Basics of thermodynamics: State, Process, Cycle, System and control volume concept,Enthalpy and Entropy, Types of thermodynamic processes.	1
4.2	Carnot, Otto and Diesel cycles, Efficiency, Problems	2
4.3	Working of SI and CI engine, Two stroke and Four stroke engine, IC engine parts.	2
4.4	Fuel, Cooling and Lubrication systems, CRDI and MPFI engines.	2
4.5	Concept of hybrid engines.	1
	Module 5	**7**
5.1	Power Transmission Elements: Classification and applications of mechanical drives.	1
5.2	Velocity ratio of belt drive.	1
5.3	Length of belt, Slip in belt, Power transmitted. Gear drive: Types, Gear Ratio, Simple, compound and epicyclic gear trains (simple descriptions only)	3
5.4	Automotive Drives: Manual Transmission, Automatic Manual Transmission (AMT), Continuous Variable Transmission (CVT), Torque converter.	2
	Module 6	**8**
6.1	Refrigeration, Air conditioning, Vapour Compression Refrigeration system, Summer and winter air conditioning.	2
6.2	Basic description of the manufacturing processes (Basic Concepts only and examples of products)	1
6.3	Die Casting, Forging, Rolling, Extrusion.	2
6.4	Basic description of Lathe and Drilling Machine, Lathe operations.	1
6.5	Basic description of Metal Joining Processes: Arc and gas Welding, Soldering and Brazing, their applications.	2
	Total Hours	**46 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Define the role of a civil engineer in society
2. Address complex challenges in the built environment.
3. How do civil engineers contribute to the development of environmentally conscious infrastructure.

Course Outcome 2 (CO 2):

1. Examine the role of materials in green building construction
2. Evaluate the integration of energy systems in green buildings.
3. How do green building practices address water conservation, reuse, and efficient management of water resources?

Course Outcome 3 (CO 3):

1. Compare and contrast the characteristics and purposes of residential, commercial, and industrial buildings.
2. Discuss the importance of building components in the construction process.
3. How have innovations in techniques influenced the efficiency, sustainability, and safety of construction practices?

Course Outcome 4 (CO 4):

1. Describe the working of a four-stroke diesel engine.
2. Why two stroke engines are less efficient than four stroke engine?
3. In an Isothermal process, Why does the temperature remains constant despite the heat exchange?

Course Outcome 5 (CO 5):

1. Derive an expression to determine the length of an open belt drive
2. Explain the working of CVT system.
3. What are the advantages of AMT Vehicles?.

Course Outcome 6 (CO 6):

1. With the aid of a neat sketch, explain the working of a Vapour Compression Refrigeration system.
2. List the commonly used metal joining processes in manufacturing.
3. How the operation of a summer air conditioner differs from a winter air conditioner

MODEL QUESTION PAPER

QP CODE: **Pages: 3**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24ES1T05B

Answer both part I and part 2 in separate answer booklets

Course Name: BASIC CIVIL AND MECHANICAL ENGINEERING

Max. Marks: 100 Duration: 3 hours

Answer both part I and part 2 in separate answer booklets

PART I: BASIC CIVIL ENGINEERING

PART A

Answer all questions. Each question carries 4 marks.

1. How does Civil Engineering contribute to the comprehensive development of a country's infrastructure?
2. How does the increase in ground resistance due to earth pitting mechanisms affect the safety and reliability of equipment?
3. Elaborate on how the Floor Area Ratio (FAR) is determined for a building
4. Compare load-bearing masonry structures and framed structures.
5. Provide examples of machinery foundation types and their applications in various industrial settings.

PART B

Answer any one question from each module. Each question carries 10 marks.

Module 1

6. Provide a concise overview of the basic principles, instruments, methods, and measurements involved in surveying. 10

OR

7. How do water supply and sanitary systems, urban air pollution management, solid waste management, and urban flood control collectively contribute to environmental sustainability in urban areas? 10

Module 2

8. How do green buildings incorporate sustainable practices in terms of materials, energy systems, water management, and overall environmental considerations? 10

OR

9. Explain the essential components of a residential building and elaborate on their functions within the functionality of the structure. 10

Module 3

10. Elaborate on the structural characteristics and load-bearing capabilities of brick masonry, stone masonry, and rubble masonry. 10

OR

11. (a) What advantages do steel trusses offer in terms of strength, span capabilities, and cost-effectiveness? 6
    (b) How do industrial roofing requirements differ from those of residential structures, and what specific roofing materials are commonly used in industrial buildings? 4

PART II: BASIC MECHANICAL ENGINEERING

PART A

Answer all questions. Each question carries 4 marks

1. With the neat block diagram, explain the fuel system of a CI engine.
2. Illustrate the working of an epicyclic gear train.
3. Explain velocity ratio in belt drive.
4. Explain Arc welding and Gas welding with suitable sketches.
5. Define: Casting and forging processes.

PART B

Answer all questions. Each question carries 10 marks

Module 4

6. Explain the working of a 4-stroke CI engine with the help of a neat diagram. 10

OR

7. Derive the air standard efficiency of Diesel Cycle 10

Module 5

8. (a) What are the different modes of power transfer? 5
   (b) What is slip in belt drive? Why it is an undesirable effect? 5

OR

9. (a) Explain the working of a torque convertor. 4
   (b) Compare manual and automatic transmission in automobiles 6

Module 6

10. (a) How summer air conditioners differ from winter air conditioners. 5
    (b) Explain the working of summer air conditioner with a neat sketch 5

OR

11. With a neat sketch, Explain the different components of a Lathe. 10

B24ME1T01	ENGINEERING GRAPHICS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	2	4	4	2024

Preamble

This course aims at equipping students with the ability to communicate technical concepts through global-standard graphical representation. Students learn to interpret existing engineering drawings accurately and convey design information effectively. Emphasis is placed on mastering graphical communication techniques to meet industry standards. By the end of the course, students will have the skills to articulate complex engineering information visually and interpret engineering drawings with precision.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Draw the projection of points and lines located in different quadrants. (Cognitive Knowledge Level: Analyse)
CO 2	Prepare multi view orthographic projections of objects by visualizing them in different positions. (Cognitive Knowledge Level: Apply)
CO 3	Draw sectional views and develop surfaces of a given object.(Cognitive Knowledge Level: Apply)
CO 4	Prepare pictorial drawings using the principle of isometric projections and convert 3D views to orthographic views. (Cognitive Knowledge Level: Analyse)
CO 5	Prepare pictorial drawings using the principle of perspective projections.(Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	2				1		1		1
CO 2	3	2	2	2				1		1		1
CO 3	3	2	2	2				1		2		1
CO 4	3	2	2	2				1		2		1
CO 5	3	2	2	2				1		2		1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember			
Understand	40	40	30
Apply	30	30	40
Analyse	30	30	30
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Class work	15 marks

End Semester Examination Pattern

ESE will be of 3-hour duration on A4 size answer booklet and will be for 100 marks. The question paper shall contain two questions from each module. Student has to answer any one question from each module. Each question carries 20 marks

SYLLABUS

MODULE 1 (12 hours)

Introduction: Relevance of technical drawing in engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing.
Orthographic projection of Points and Lines: Projection of points in different quadrants, Projection of straight lines inclined to one plane and inclined to both planes. Trace of line. Inclination of lines with reference planes True length of line inclined to both the reference planes.

MODULE 2 (12 hours)

Orthographic projection of Solids: Projection of Simple solids such as Triangular, Rectangle, Square, Pentagonal and Hexagonal Prisms, Pyramids, Cone and Cylinder. Projection of solids in simple position. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.

MODULE 3 (11 hours)

Sections of Solids: Sections of Prisms, Pyramids, Cone, Cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Also locating the section plane when the true shape of the section is given.
Development of Surfaces: Development of surfaces of the above solids and solids cut by different section planes. Also finding the shortest distance between two points on the surface.

MODULE 4 (10 hours)

Isometric Projection: Isometric View and Projections of Prisms, Pyramids, Cone, Cylinder, Frustum of Pyramid, Frustum of Cone, Sphere, Hemisphere and their combinations.
Conversion of Pictorial Views: Conversion of pictorial views into orthographic views.

MODULE 5 (10 hours)

Perspective Projection: Perspective projection of Prisms and Pyramids with axis perpendicular to the ground plane and axis perpendicular to picture plane.
Intersection of surfaces: Methods of determining lines of intersection - Intersection of prism in prism and cylinder in cylinder.

Text Books

1. Bhatt, N.D., Engineering Drawing, Charotar Publishing House Pvt. Ltd.

2. John, K.C. Engineering Graphics, Prentice Hall India Publishers.

3. K.N. Anilkumar, Engineering Graphics, Adhyuth Narayan Publishers.

4. P I. Varghese, Engineering Graphics, VIP Publishers

Reference Books

1. Agrawal, B. and Agrawal, C.M., Engineering Drawing, Tata McGraw Hill Publishers.

2. Duff, J.M. and Ross, W.A., Engineering Design and Visualisation, Cengage Learning.

3. Kulkarni, D.M., Rastogi, A.P. and Sarkar, A.K., Engineering Graphics with AutoCAD, PHI.

4. Luzaddff, W.J. and Duff, J.M., Fundamentals of Engineering Drawing, PHI.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Module 1	**12**
1.1	**Introduction:** Relevance of technical drawing in Engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing.	1
1.2	Concept of principal planes of projection, different quadrants, locating points on different quadrants	2
1.3	Projection of lines, inclined to one plane and Lines inclined to both planes,	4
1.4	Problems on lines using trapezoid method	2
1.5	Line rotation method of solving, problems on line rotation method	3
	Module 2	**12**
2.1	Introduction of different solids, Simple position plan and elevation of solids	3
2.2	Problems on views of solids inclined to one plane	2
2.3	Problems on views of solids inclined to both planes	4
2.4	Practice problems on solids inclined to both planes	3
	Module 3	**11**
3.1	Introduction to section planes. Principle of locating cutting points and finding true shape	2
3.2	Problems on sections of different solids and Problems when the true shape is given	4
3.3	Principle and development of simple solids	2
3.4	Development of solids and sectioned solids	3
	Module 4	**10**
4.1	Principle of Isometric View and Projection, Isometric Scale. Problems on simple solids	2
4.2	Isometric problems on Frustum of solids, Sphere and Hemisphere	3
4.3	Problems on combination of different solids	3
4.4	Practice on conversion of pictorial views into orthographic views	2
	Module 5	**10**
5.1	Introduction to perspective projection, different planes, station point etc. Perspective problems on pyramids	2
5.2	Perspective problems on prisms	4
5.3	Intersection of surfaces: methods of determining lines of intersection - intersection of prism in prism and cylinder in cylinder.	4
	Total Hours	**54 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Locate points in different quadrants as per given conditions.
2. Problems on lines inclined to both planes.
3. Find True length, Inclinations and Traces of lines.

Course Outcome 2 (CO 2):

1. Draw orthographic views of solids and combination solids .
2. Draw views of solids inclined to any one reference plane.
3. Draw views of solids inclined to both reference planes.

Course Outcome 3 (CO 3):

1. Draw views of solids sectioned by a cutting plane.
2. Find location and inclination of cutting plane given true shape of the section.
3. Draw development of lateral surface of solids and also its sectioned views.

Course Outcome 4 (CO 4):

1. Draw Isometric views/projections of solids
2. Draw Isometric views/projections of combination of solids
3. Draw Orthographic views of solids from given three-dimensional view

Course Outcome 5 (CO 5):

1. Draw Perspective views of Solids
2. Draw Intersection of surfaces of two identical solids

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24ME1T01

Course Name: ENGINEERING GRAPHICS

Max. Marks: 100 Duration: 3 hours

Answer any one question from each module. Each question carries 20 marks

Instructions: Retain construction lines. Show necessary dimensions

Module I

1. The end point A of a line is 20mm above HP and 10mm in front of VP. The other end of the line is 50mm above HP and 15mm behind VP. The distance between the end projectors is 70mm. Draw the projections of the line. Find the true length and true inclinations of the line with the principal planes. Also locate the traces of the line.

2. One end of a line is 20mm from both the principal planes of projection. The other end of the line is 50mm above HP and 40mm in front of VP. The true length of the line is 70mm. Draw the projections of the line. Find its apparent inclinations, elevation length and plan length. Also locate its traces.

Module II

3. A pentagonal pyramid of base side 25mm and height 40mm, is resting on the ground on one of its triangular faces. The base edge of that face is inclined 30^0 to VP. Draw the projections of the solid.

4. A hexagonal prism has side 25mm and height 50mm has a corner of its base on the ground and the long edge containing that corner inclined at 30^0 to HP and 45^0 to VP. Draw the projections of the solid.

Module III

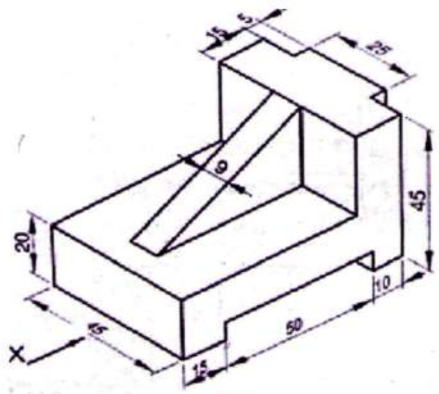
5. A triangular prism of base side 40mm and height 70mm is resting with its base on the ground and having an edge of the base perpendicular to VP. Section the solid such that the true shape of the section is a trapezium of parallel sides 30mm and 10mm. Draw the projections showing the true shape. Find the inclination of the cutting plane with the ground plane

6. Draw the development of a pentagonal pyramid of base side 30mm and height 50mm. A string is wound from a corner of the base round the pyramid and back to the same point through the shortest distance. Show the position of the string in the elevation and plan.

Module IV

7. The frustum of a cone has base diameter 50mm and top diameter 40mm has a height of 60mm. It is paced centrally on top of a rectangular slab of size 80x60mm and of thickness 20mm. Draw the isometric view of the combination.

8. Draw three orthographic views with dimensions of the object shown in figure below.



Module V

9. Draw the perspective view of a pentagonal prism, 20mm side and 45mm long lying on one of its rectangular faces on the ground and having its axis perpendicular to picture plane. One of its pentagonal faces touches the picture plane and the station point is 50mm in front of PP, 25mm above the ground plane and lies in a central plane, which is 70mm to the left of the center of the prism.

10. A square prism 50mm side and height 100 mm stands vertically with its base on HP with two of its adjacent rectangular faces inclined equally to VP. Another horizontal square prism of the same size penetrates the vertical prism such that the axes of the two prisms bisects each other at right angles. If the two adjacent faces of the horizontal prism are inclined equally to HP, draw the projections showing the lines of intersections.

B24ES1L04B	BASIC CIVIL AND MECHANICAL WORKSHOP	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	2	2	1	2024

Preamble

The aim of this course is to help students to gain practical knowledge with a correlation to theoretical studies and encourage them to understand physical problems. Students will demonstrate an understanding of various disciplines of civil and mechanical engineering while acquiring hands-on training with various tools and processes. The course is designed to train students to identify and manage the tools, materials, and methods required to execute an engineering project.

Prerequisite

NIL

Course Outcomes

After the completion of the course the student will be able to

CO 1	Identify and select appropriate plumbing materials for different applications and Familiarize with a range of building materials, their properties, and applications in construction. (Cognitive Knowledge Level: Apply)
CO 2	Develop proficiency in using standard measuring tape and digital distance measuring devices to accurately calculate the area of built-up spaces and small parcels of land and compute the area and or volume of various features in a structure. (Cognitive Knowledge Level: Apply)
CO 3	Develop skills in drawing foundation plans, indicating wall thickness and foundation width, emphasizing the importance of accurate planning in construction. (Cognitive Knowledge Level: Analyse)
CO 4	Identify and use various tools in carpentry & sheet metal work and perform multiple operations for the preparation of joints using wood and fabrication using sheet metal. (Cognitive Knowledge Level: Apply)
CO 5	Identify and use various tools in smithy & foundry and to practice forging, moulding, and casting. (Cognitive Knowledge Level: Apply)
CO 6	Identify and use various tools used in fitting and welding and perform operations such as chipping, filing, cutting, drilling, etc., and prepare multiple joints and welds. (Cognitive Knowledge Level: Analyse)

Mapping of Course Outcomes With Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2				2	1		3	1	1	2
CO 2	3	3	2		2	1			3	1	1	3
CO 3	3	3	2		2	1			3	1	1	3
CO 4	1	1	1						2	1	1	2
CO 5	1	1	1						2	1	1	2
CO 6	1	1	1						2	1	1	2

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	70	30	1 hours

Continuous Internal Evaluation Pattern

Attendance	20 marks
Class Work/ Assessment / Viva-Voce	50 marks
End semester examination (Internally by college)	30 marks

End Semester Examination Pattern

The college will internally conduct the end semester examination. Separate ESE's will be held for the Civil workshop and the Mechanical workshop, each in the form of a one-hour written objective exam. The total marks for this course will be equally divided between the Civil and Mechanical workshops.

SYLLABUS

LIST OF EXPERIMENTS

PART 1

CIVIL WORKSHOP

Sl.No.	**Topic**
1	Plumbing: Introduction to plumbing and sanitary fittings.
2	Building Materials: Familiarization of various building materials- bricks, wood, steel and concrete with demonstration of its testing for fitness.
3	Calculate the area of a built-up space and a small parcel of land using standard measuring tape and digital distance measuring device.
4	Compute the area and/or volume of various building elements - door and window, quantity of bricks required to construct a wall of a building, quantity of steel bars used in windows (to create an awareness of measurements and units).
5	Prepare line sketch of a building showing the position of doors, windows and ventilators
6	Prepare the foundation plan (not to scale) of a small single storey building showing its cross section.

Reference Books

1. J. Paul Guyer," Plumbing Engineering Services Design Guide"
2. S. K. Duggal, "Building Materials", New Age International, 2019.
3. B. N. Dutta," Estimating and Costing in Civil Engineering", UBS Publishers, 2016.
4. Ralph B. Peck, Walter E. Hanson, Thomas H. Thornburn, "Foundation Engineering", John Wiley & Sons
5. Varghese P.C, "Design of Reinforced Concrete Foundations", PHI, 2009.
6. J.L. Meriam and L.G. Kraige, "Engineering Mechanics: Statics", John Wiley & Sons, 2017.
7. S. Timoshenko and D.H. Young, "Engineering Mechanics", McGraw Hill Education, 2017.

PART 2

MECHANICAL WORKSHOP

(Five models from exercises 1 to 8 are mandatory. Additionally, the study and demonstration of the remaining exercises are also required.)

Sl.No.	Topic
1	Carpentry: Study of Carpentry tools, Carpentry joints practices: T-Lap joint, Cross lap joint / Cross halving joint, Dove tail halving joint, Mortice & Tenon Joint
2	Sheetmetal: - Study of sheet metal tools, Forming and joint practices: Cylindrical shape, Conical shape, Rectangular Tray
3	Smithy: - Study of different tools & forged models in Smithy shop, Forging Practices: Square prism, Hexagonal headed bolt, octagonal prism
4	Foundry: - Study of Foundry tools, Molding practices: Bench molding, Floor molding, Core making, Casting
5	Fitting: - Study of Fitting tools in a workshop, Fitting shop joints practices: Square Joint, V-Joint, Male and Female fitting
6	Welding: - Study of Welding tools, equipment's and methods, Welding practices: Arc Welding, MIG Welding, Oxy-Acetylene Gas Welding
7	Conventional Machines: Study and demonstration of conventional machines like Shaping and Slotting machine, Lathe, Milling machine, Grinding machines & Radial drilling machine
8	Advanced Manufacturing Methods: Study and demonstration of CNC machines and 3D printing

Reference Books

1. Chapman, W. A. J, Workshop Technology - Parts 1 and 2, 4^{th} ed., New Delhi, India, CBS Publishers & Distributors Pvt. Ltd, 2007.

2. O'Bren, A. (Editor), Welding Handbook. 9^{th} ed., Miami, American Welding Society, 2001.

3. Anderson, J., Shop Theory, New Delhi, India, Tata McGraw Hill, 2002.

4. Douglass, J. H., Wood Working with Machines, Illinois, McKnight & McKnight Pub. Co., 1995.

5. Tuplin, W. A., Modern Engineering Workshop Practice, Odhams Press, 1996.

6. Jain, P. L., Principles of Foundry Technology, 5^{th} ed., New Delhi, India, Tata McGraw Hill, 2009.

7. S.K. Hajra Choudhury, Workshop Technology Vol II, Media Promoters & Publishers, 2010.

B24ES1L01B	PROGRAMMING LAB (B)	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	2	2024

Preamble

This course introduces students to problem-solving using Python programming, offering hands-on experience with core concepts such as data types, control structures, functions, file handling, and data analysis. By engaging in practical exercises, students will develop the skills necessary to analyse complex engineering problems and implement effective solutions using Python.Upon completing this course, students will be equipped to apply Python to real-world engineering challenges, enhancing their computational thinking and technical proficiency.

Prerequisite
Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Use fundamental Python constructs to solve basic computational problems (Cognitive Knowledge Level: Apply)
CO 2	Solve problems using data structures, logical conditions, and control loops enhancing their problem-solving skills (Cognitive Knowledge Level: Apply)
CO 3	Create functions and use inbuilt Python libraries to perform calculations and solve practical problems (Cognitive Knowledge Level: Apply)
CO 4	Manage and manipulate files and directories in Python (Cognitive Knowledge Level: Apply)
CO 5	Manipulate data using fundamental Python packages/libraries to perform mathematical operations and statistical analysis (Cognitive Knowledge Level: Analyse)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3									1
CO 2	3	3	3									1
CO 3	3	3	3									1
CO 4	3	3	3									1
CO 5	3	3	3	3								1

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	15 marks
Class Work/ Assessment Viva-Voce	15 marks
Viva-Voce/ Test	20 marks

End Semester Examination (ESE) Pattern:

The following guidelines should be followed regarding the award of marks

Algorithm	20 marks
Program	30 marks
Viva-Voce	30 marks
Output	20 marks

SYLLABUS

LIST OF EXPERIMENTS

18 experiments from the following list of experiments are mandatory. At least 3 questions should be given from each set. The study and discussion of the remaining are also required.

	SET 1
1	Write a Python program to swap the values of two variables without using a third variable.
2	Write a Python program that accepts a single numeric parameter representing an angle in radians to convert into degree.
3	Implement a Python program that calculates simple interest based on user input for the principal amount, rate of interest, and time.
4	Create a Python program that takes a single character input and determines whether it is a vowel or consonant.
5	Write a Python programme to solve a quadratic equation. The inputs shall be taken from the user.
	SET2
6	Write a Python program to find the first n prime numbers.
7	Write a Python program to check if a given year is a leap year

8	Write a Python program to read a string (word), store it in an array and check whether it is a palindrome.
9	Create a program that takes a tuple of numbers, converts it to a list, adds a new element, and then converts it back to a tuple.
10	Write a program to create a dictionary with student names as keys and their scores as values. Implement a search feature to find a student's score by name.
	SET 3
11	Write a function that returns the n^{th} Fibonacci number. Test the function with various values of n.
12	Write a program that simulates rolling a six-sided die 10 times and prints the result of each roll using the random module.
13	Create a custom module named `math_utils.py` with a function factorial(n) that returns the factorial of a number n. Import this module in a script and use the factorial() function.
14	A person needs to file his Income Tax Returns. He doesn't know if new regime or the old regime is beneficial. Please help him out by writing a Python program asking him the gross salary and possible deductions. You may use functions and Python libraries.
15	Write a Python function that takes two parameters: a list of numbers and a second parameter that can have one of three values: "asc", "desc", or "none". If the second parameter is "asc", the function should return the list of numbers in ascending order. If it is "desc", the function should return the list of numbers in descending order. If the second parameter is "none", the function should return the unaltered list.
	SET 4
16	Write a program that finds and prints the longest line in the file 'lines.txt'. The file will be kept in a prescribed directory.
17	Write a program that writes a list of dictionaries to a CSV file 'output.csv' and text file 'output.txt' both in a folder named 'data'.
18	Write a Python program that lists all the files in the current directory.
19	Write a Python program that searches for a specific word in a file and replaces it with another word. The program should save the changes to the same file. Also count the number of words replaced.
20	Reads the first 5 lines from an existing text file using the readline() method. If the file doesn't exist, handles the error using try and except, and creates a new file with the same name. Writes user input line by line into the file until the user decides to stop, ensuring the file is properly saved.
	SET 5
21	Create a NumPy array with random integers between 0 and 100 of size 5x5. Compute and print the mean, median, standard deviation, and sum of all elements. Find the row wise and column wise sum of the elements of the matrix. Perform matrix multiplication and display the result along with the multiplied ones. Find the element wise product, sum and difference find the sum of squares of all the elements row wise and display the result.

22	Read a csv file where the details of students and their marks obtained in various subjects are given. Remove the students from the list who is absent for any one of the exams where it displays ‘abs’ against the subject. Find the percentage of marks for each student and add it as the last column and save the updated file in a new name. Also display the names of students that scored more than 80% marks.
23	Load a CSV file containing sales data with columns for product name, quantity sold, and price. Calculate the total sales revenue for each product and identify the product with the highest revenue.
24	Generate a 10x10 matrix of random integers, extract all even numbers, and replace them with their negative values and all odd numbers to double their values. Find the minimum and maximum elements in the matrix.
25	Generate a line plot of the sine and cosine functions from 0 to 2π using Matplotlib. Give a title, label the axes and add a legend. Save the plot. Try the same for a scatter plot.

Reference Books

1. Eric Matthes, “Python Crash Course”, No Starch Press
2. Cay S Horstmann, Rance D Necaise, “Python For Everyone”, Wiley
3. Guttag John V, “Introduction to Computation and Programming using Python”, PHI
4. Kenneth A Lambert, “Fundamentals of Python: First Programs”, Cengage

B24MC1T01	LIFE SKILLS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		1	0	1	2	P/F	2024

Preamble

This Course is aimed at equipping individuals with the essential competencies to navigate life's challenges with resilience and positivity. This course, embarks on a profound exploration of personal development, fostering self-awareness, meaningful connections, and the ability to navigate the complexities of both the abstract and the concrete aspects of life. It aims to enhance employability by providing practical insights and hands-on experiences that will empower one to apply these principles effectively in one's personal and professional endeavors.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Empower individuals with the knowledge and practical skills needed to navigate life challenges and to cope with emotions and stress. (Cognitive Knowledge Level: Apply)
CO 2	Develop a profound understanding of themselves and others, leading a fulfilling professional life by embracing a holistic approach to well being (Cognitive Knowledge Level: Analyze)
CO 3	Provide a solid foundation in leadership principles and team dynamics. (Cognitive Knowledge Level: Apply)
CO 4	Basic understanding of financial concepts for financial well being. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1			1			2			2			3
CO 2						3	1	2	2	2		2
CO 3									3			2
CO 4		1	1								3	

Assessment Pattern

Bloom's Category	Continuous Assessment	End Semester Examination (% Marks)
	Test (%Marks)	
Remember	20	20
Understand	20	20
Apply	30	30
Analyse	30	30
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks
100	50	50

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (1 numbers)	25 marks
Regular assessment	15 marks

Regular assessment

Group Discussion (Marks: 9)
Create groups of about 6 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation are as follows:

1. Communication Skills: 3 marks
2. Subject Clarity: 2 marks
3. Group Dynamics: 2 marks
4. Behaviors Mannerisms: 2 marks

Presentation Skills (Marks: 6)
Identify a suitable topic and ask the students to prepare presentation (preferably a powerpoint presentation) for about 10 minutes. Parameters to be used for evaluation are as follows

1. Communication Skills: 2 marks

2. Platform Skills: 2 marks
3. Subject Clarity/Knowledge: 2 marks

End Semester Examination Pattern

Part A: Short answer question (20 marks)
There will be one question from each MODULE (four questions in total, five marks each). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows:

1. Content Clarity/Subject Knowledge
2. Presentation style
3. Organization of content

Part B: Case Study (30 marks)
The students will be given a case study with questions at the end. The students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows:

1. Analyze the case situation
2. Key players/characters of the case
3. Identification of the problem (both major minor if exists)
4. Bring out alternatives
5. Analyze each alternative against the problem
6. Choose the best alternative
7. Implement as solution
8. Conclusion
9. Answer the question at the end of the case

SYLLABUS

MODULE 1 (6 hours)

Overview of Life Skills:

Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress- Four A's of stress management, Gratitude Training, Coping with emotion- PATH method and relaxation techniques.

MODULE 2 (6 hours)

Life Skills for Professionals:

positive thinking, right attitude, Experience, attention to detail, having the big picture, learning skills, research skills, setting goals and achieving them, perseverance, motivation, self-motivation, and motivating others, IQ, EQ, and SQ , Collaboration, continuous learning, unlearning and relearning, cross cultural communication, social media etiquettes, Financial Literacy.
Time Management: Prioritizing tasks, setting realistic goals and managing time effectively, work life balance.
Holistic Thinking: imagination, intuition, lateral thinking, Multiple intelligence, spirituality, family bonding, living peacefully.

MODULE 3 (6 hours)

Leadership:

Leadership traits, Styles of Leadership, VUCA Leadership, Transactional vs Transformational Leaders, managing diverse stakeholders, crisis management, Effective Leaders.
Group and Team Dynamics: Group vs Team, Team Dynamics, Virtual teams, managing team performance and managing conflicts, Intrapreneurship

MODULE 4 (6 hours)

Financial Literacy:

Time value of money, power of compounding, Future value of a single cash flow, effective versus nominal rate, Future value of an annuity, present value of a single cash flow, Present value of an annuity.

Reference Books

1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.

2. Barun K. Mitra, “Personality Development Soft Skills”, Oxford Publishers, Third impression, 2017.

3. ICT Academy of Kerala, ”Life Skills for Engineers”, McGraw Hill Education (India) Private Ltd.,2016.

4. Caruso, D. R. and Salovey P, "The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership", John Wiley Sons, 2004.
5. Kalyana, "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd, 2015.
6. Larry James, "The First Book of Life Skills"; First Edition, Embassy Books, 2016.
7. Shalini Verma, "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) Company, 2014.
8. Daniel Goleman, "Emotional Intelligence"; Bantam, 2006.
9. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
10. Butterfield Jeff, "Soft Skills for Everyone", Cengage Learning India Pvt Ltd; 1 edition, 2011.
11. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6 editions, 2015. Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013
12. Prasanna Chandra, "Fundamentals of Financial Management", McGraw Hill Education (India) Private Ltd,2020
13. Edward de Bono, "Lateral Thinking"
14. Howard Gardener, "Multiple Intelligences"

COURSE CONTENTS AND LECTURE SCHEDULE

No	**Topic**	**No of Lecture/Tutorial Hours**
	Total Hours	24 Hours
	Module 1	6
1.1	Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making	1
1.2	Problem solving, Effective communication, interpersonal relationship, coping with stress- Four A's of stress management.	1
1.3	Gratitude Training, Coping with emotion- PATH method and relaxation techniques	1
1.4	Activity- Presentation, Group discussion	3
	Module 2	6

2.1	Life skills for professionals: positive thinking, right attitude, Experience, attention to detail, having the big picture, learning skills, research skills, setting goals and achieving them, perseverance, motivation, self-motivation, and motivating others,	1
2.2	IQ, EQ, and SQ, Collaboration, continuous learning, unlearning and relearning, cross cultural communication, social media etiquettes, Financial Literacy.	1
2.3	Time management: Prioritizing tasks, setting realistic goals and managing time effectively, work life balance.	1
2.4	Holistic Thinking: imagination, intuition, lateral thinking, Multiple intelligence, spirituality, family bonding, living peacefully.	1
2.5	Activity- Presentation, Group discussion.	2
	Module 3:	6
3.1	Leadership: Leadership traits, Styles of Leadership, VUCA Leadership, Transactional vs Transformational Leaders, managing diverse stakeholders, crisis management, Effective Leaders.	1 hour
3.2	Group and Team Dynamics: Group vs Team, Team Dynamics, Virtual teams, managing team performance and managing conflicts, Intrapreneurship	1
3.3	Activity- Presentation, Group discussion	4
	Module 4:	6
4.1	Financial Literacy: Time value of money, power of compounding, Future value of a single cash flow.	1
4.2	Effective versus nominal rate, Future value of an annuity.	1
4.3	Present value of a single cash flow, Present value of an annuity.	1
4.4	Activity- Presentation, Group discussion	3

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. What are the life skills identified by WHO?
2. List the 4 A's of stress management.
3. Differentiate between Critical thinking and Creative thinking.

Course Outcome 2 (CO 2):

1. What are the life skills that a professional should have?
2. Explain how time management can help in work life balance.
3. What is the difference between intuition and lateral thinking?

Course Outcome 3 (CO 3):

1. How a person can grow as a leader in an organization?
2. Discuss the term “Crisis management”.
3. What are the differences between a team and a group?

Course Outcome 4 (CO 4):

1. A finance company advertises that it will pay a lumpsum of Rs. 10000 at the end of 6 years to investors who deposit annually Rs. 1000. What interest rate is implicit in this offer?
2. How much should be deposited at the beginning of each year for 10 years in order to provide a sum of Rs. 50000 at the end of 10 years?
3. Suppose you deposit Rs. 10000 with an investment company which pays 8 percent interest with quarterly compounding. How much will this deposit grow in 5 years?

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24MC1T01

Course Name: LIFE SKILLS

Max. Marks: 50 Duration: 2 hours

PART A

Answer all questions. Each question carries 5 marks.

1. Stress is the emotional or physical tension the body creates when presented with events or thoughts that cause worry, frustration, anger or nervousness. When stress exceeds the ability to cope, balance in the mind and body need to be restored. Discuss how stress management can act as an effective tool to accomplish this.
2. ”The only limit to our realization of tomorrow is our doubts of today.” – Franklin D. Roosevelt. Critically assess how cultivating positive thinking and maintaining a right attitude can transform professional challenges into opportunities for growth.
3. Discuss leadership styles that are effective for successful management of multicultural groups and teams.
4. Mr. Vinay plans to send his son for higher studies abroad after 10 years. He expects the cost of these studies to be Rs. 100000. How much should he save annually to have a sum of Rs. 100000 at the end of 10 years if the interest rate is 12 percent?

PART B

Read carefully the following case and answer the questions given below. Each question carries 6 marks.

1. Based on the case study given below, answer the following questions: It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to Methyl Isocyanate (MIC) gas and other chemicals. A runaway reaction had occurred in a storage tank of Methyl Isocyanate (MIC), which was used to manufacture a pesticide. The valves of the tank had burst, and a cloud of poisonous gas had escaped. The winds carried it to nearby shanty towns and the populous city of Bhopal, where thousands of people either died in their sleep or woke and died while fleeing. Those who survived suffered from burning eyes and lungs. Local medical facilities were not equipped for the disaster, and over the next few weeks' thousands more died. The killer gas spread through the city, sending residents scurrying through the dark streets. No alarm ever sounded a warning, so that local people were not informed the situation, and no evacuation plan was prepared. When victims arrived at hospitals breathless and blind, doctors did not know how to treat them, as UCIL had not provided emergency information. Perhaps most importantly at the time of the tragedy, the staff did not realize the gravity of the situation and even took a break for tea after the leak had been noticed, thinking they would have plenty of time to fix it. The operator in the control room did not notify his supervisor when the temperature began to rise inside the tank and the entire situation remained unattended for at least an hour. The disaster raised some serious ethical issues. The pesticide factory was built in the midst of densely populated settlements. UCIL chose to store and produce MIC, one of the deadliest chemicals (permitted exposure levels in USA and Britain are 0.02 parts per million), in an area where nearly 120,000 people lived. The MIC plant was not designed to handle a runaway reaction. When the uncontrolled reaction started, MIC was flowing through the scrubber (meant to neutralize MIC emissions) at more than 200 times its designed capacity.

   (a) Critique the communication strategy (or lack thereof) employed by UCIL during the disaster. How did the absence of timely warnings and information affect the outcome?

   (b) Assess the ethical implications of UCIL's decision to build a pesticide plant in a densely populated area. How should corporate responsibility have been exercised in this context?

   (c) As an engineer, comment on the drawback of the design which may have the reason for the tragedy.

   (d) Evaluate the leadership displayed by UCIL's management during the Bhopal disaster. How did their response, or lack thereof, impact the outcome of the crisis?

   (e) Reflect on the lessons learned from the Bhopal disaster. What key takeaways should industries and governments derive from this incident to enhance safety and prevent future catastrophes?

<table>
<tr><td rowspan="2">B24MC1T02</td><td rowspan="2">DESIGN THINKING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>P/F</td><td>2024</td></tr>
</table>

Preamble

This course gives students a comprehensive understanding of the iterative design process and its real-world applications. It covers the fundamentals of design thinking, including concept development, brainstorming, and creativity enhancement. Emphasizing customer needs identification and human-centered design principles, it explores product conceptualization and evaluation, along with prototyping techniques. Additionally, the course addresses ethical considerations and challenges within the design thinking process through diverse case studies. By the end of the course, students will gain practical insights into design thinking methodologies, preparing them to effectively tackle complex design challenges.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Exhibit/show a thorough understanding of the fundamental principles of the de-sign thinking methodology. (Cognitive Knowledge Level: Understand)
CO 2	Utilize diverse techniques effectively to generate creative concepts, adopting in-novation and ideation. (Cognitive Knowledge Level: Apply)
CO 3	Demonstrate expertise in ideating prototypes, models, and proof-of-concept iterations. (Cognitive Knowledge Level: Analyse)
CO 4	Analyze real-world challenges and develop a practical design thinking framework suitable for their professional endeavors. (Cognitive Knowledge Level: Create)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	2	1			1	1	1		1	3
CO 2	2	2	2	1			1	1	1	1	1	3
CO 3	2	2	2	1			1	1	1	1	1	2
CO 4	2	2	2	1			1	1	1		2	2

Assessment Pattern Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test (%Marks)	Case Study Presentation (Marks) (%Marks)	
Remember	25		20
Understand	25		20
Apply	25		20
Analyse	25		20
Evaluate			
Create		100	20

Mark Distribution

Total Marks	CIE Marks	ESE Marks
100	50	50

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test	25 marks
Case study Presentation	15 marks

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 4 questions carrying 5 marks each. Part B contains 2 questions from each module out of which 1 to be answered and can have maximum 2 sub- divisions. Questions from Module 1&2 carries 8 marks each and Module 3&4 carries 7 marks.

SYLLABUS

MODULE 1 (5 hours)

Design Thinking Approach:

Introduction to Design Thinking; Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test; The double-diamond Model of design by British Design Council.

Developing concepts:

Steps to develop concepts from functions; Brainstorming: Mechanism of brainstorming, Ideation; Creativity: How to increase level of creativity.

MODULE 2 (6 hours)

Design Process: Requirements: Identifying customer needs and requirements, market analysis, defining goals; Product concepts: establishing functions, task specifications.
Solution Concept: conceptualization, evaluating alternatives; embodiment design; Analysis and optimization; experiment; marketing. Human-centred design process.

MODULE 3 (6 hours)

Concepts Evaluation:: Evaluating conceptual alternatives: Pugh's Evaluation matrix, decision matrix with examples, QFD and house of quality.
Prototyping: Prototypes, Models and Proofs of concepts; What is Prototype? Why Prototype? Building models and prototypes, Rapid Prototyping; Lean startup method for prototype development; Testing prototypes and models and proving concepts.

MODULE 4 (7 hours)

Ethics in Design: Understanding obligations, code of ethics, familiarity with several code of ethics such as ASCE, ASME, IEEE, VDI etc. code of ethics and moral frameworks.
Challenges in Design Thinking: Design thinking case studies detailing the various aspects detailed above are to be discussed. The case studies are suggested to be from the below listed areas but not to be limited to: Consumer package goods; Education; Financial Services; Health care; Journalism; Non-Profit organizations; Retail; Technology; Transportation sector; Self-improvement.

Text Books

1. Yousef Haik Tamer M Shahin, "Engineering design process", Course Technology, 2010.

2. Clive L Dym, Patrick Little Elizabeth J Orwin, "Engineering Design-A Project based Introduction", Wiley, 2014.

3. Don Norman, "The Design of Everyday Things", Basic Books; 2nd edition, 2013.

4. Christian Mueller-Roterberg, "Handbook of Design Thinking: Tips and Tools for how to design thinking", 2018.

Reference Books

1. Daniel Kahneman, "Thinking Fast and Slow", Farrar, Straus Giroux, 201.

2. Rod Judkins, "The art of Creative Thinking", Penguin Publishing Group, 2016.

3. Donella H Meadows, “Thinking in Systems”, Chelsea Green Publishing, 2008.

4. Tim Brown, “Change by Design”, HarperCollins, 2019.

5. V.N.Mittle & Arvind Mittal, ”Basic Electrical Engineering ” 2^{nd} Edition, McGraw Hill, 2006.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Total Hours	24 Hours
	Module 1	5
1.1	Design Thinking Approach: Introduction to Design Thinking; Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test	1
1.2	The double-diamond Model of design by British Design Council	1
1.3	Developing concepts: Steps to develop concepts from functions	1
1.4	Brainstorming: Mechanism of brainstorming, Ideation	1
1.5	Creativity: How to increase level of creativity	1
	Module 2	6
2.1	Design Process: Requirements: Identifying customer needs and requirements, market analysis, defining goals	1
2.2	Product concepts: establishing functions, task specifications	2
2.3	Solution Concept: conceptualization, evaluating alternatives	1
2.4	Embodiment design; Analysis and optimization; experiment; marketing	1
2.6	Human centred design process	1
	Module 3:	6
3.1	Concepts Evaluation: Evaluating conceptual alternatives: Pugh’s Evaluation matrix, decision matrix with examples.	2
3.2	Prototypes, Models and Proofs of concepts	1
3.3	What is Prototype? Why Prototype? Building models and prototypes, Rapid Prototyping	1
3.4	Lean startup method for prototype development; Testing prototypes and models and proving concepts	2
	Module 4:	7

4.1	Ethics in Design: Understanding obligations, code of ethics, familiarity with several code of ethics such as ASCE, IEEE, VDI etc. code of ethics and moral frameworks	1
4.2	Challenges in Desing thinking	1
4.3	Design thinking case studies detailing the various aspects	5

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Describe design thinking and list the different stages in a design thinking process.
2. Illustrate the double-diamond Model of design.
3. Describe how to develop concepts from functions and Mechanism of brainstorming.
4. How to increase the level of creativity and the process of forming ideas from conception to implementation?

Course Outcome 2 (CO 2):

1. How to narrow down to the best design considering the customer needs and requirements, market analysis and defining goals?
2. Illustrate the process of product concepts, forming ideas and embodiment design.
3. Explain the Human-centred design process.

Course Outcome 3 (CO 3):

1. Describe the concept evaluation using Pugh's Evaluation matrix, and decision matrix with examples.
2. Explain the ideation of prototypes, models, and proofs of concepts.
3. Illustrate the concept of Rapid Prototyping, the Lean startup method for prototype development and testing of prototypes.

Course Outcome 4 (CO 4):

1. Discuss as an engineer, how ethics play a decisive role in design.
2. Analyze the Challenges in Design thinking.
3. Design the functional structure of a shopping cart.
4. Examine the changes that can be made in the design of a bag with constraints of cost, reliability issues, production methods and environmental factors.

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: B24MC1T02

Course Name: DESIGN THINKING

Max. Marks: 50 Duration: 2 hours

PART A

Answer all questions. Each question carries 5 marks.

1. Demonstrate the basic concept of brainstorming and the rules developed for brainstorming session.
2. Briefly explain what is product and solution concepts in design process.
3. Distinguish between prototypes and models.
4. Explain the importance of ethics in design.

PART B

Answer any one question from each module.

5. What do you mean by design thinking and why it is needed. How does the design thinking approach help engineers. 8

OR

6. Summarize different stages of design thinking process using appropriate examples.. 8
7. Illustrate different phases of extensive prescriptive model of design process. 8

OR

8. Identifyl the customer requirements with the help of refrigerator as example, 8

9. How concepts evaluation can be done using Pugh's evaluation matrix. Compare Pugh's evaluation matrix with the decision matrix. 7

OR

10. List the different methods in which the prototype of a product can be generated and tested. 7

11. Design a device/machine that will crush aluminum cans. The device must be fully automatic. The device should switch on automatically, crush the can automatically, eject the crushed can automatically and switch off automatically. 7

OR

12. Design a new shopping cart that can be used primarily in grocery stores. The shopping cart should solve the common problems in the available carts. There is a tendency to conserve parking space by not designating a return cart area. Leaving cart in the parking lots may lead to serious accidents and car damage. Many customers do not fill their carts when shopping; however, they do not like to carry baskets. Other customers like to sort products as they shop. 7

B24MC1L01	YOGA AND SPORTS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	1	1	1	P/F	2024

Preamble

This course enables the learners to understand how to attain physical fitness, mental well-being, and holistic growth through the combined benefits of yoga and sports. The topics covered in this course are Yoga Lifestyle Physical fitness, wellness and exercise programmes, First aid and Postures nutrition. This course helps the students to develop appreciation of physical activity as a lifetime pursuit and a means to better health.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Demonstrate the need of physical activities and Yoga for the strength, flexibility, and relaxation of mind and body. (Cognitive Knowledge Level :Apply))
CO 2	Use scientific principles of exercise and training in daily routine. (Cognitive Knowledge Level :Apply)
CO 3	Apply first aid promptly and appropriately whenever and wherever the need arises.(Cognitive Knowledge Level :Apply)
CO 4	Understand the importance of postures and nutrition (Cognitive Knowledge Level :Understand)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1								2	3	2		2
CO 2								3	3	2		2
CO 3						2		3	3	3		2
CO 4								3	3	2		2

Mark Distribution

Total Marks	CIE Marks
50	50

Continuous Internal Evaluation Pattern

Attendance	10 marks
Regular assessment	40 marks

Marks for the regular assessment can be based on the co questions given at the end.

SYLLABUS

MODULE 1 (6 hours)

Yoga Lifestyle:

Meaning and importance of Yoga. Introduction-Asanas: Pranayama, Meditation and Yogic Kriyas. Yoga for concentration and related Asanas (Sukhasana; Tadasana; Padmasana and Shashankasana). Relaxation Techniques for improving concentration-Yog-nidra.Asanas as preventive measure.Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.Obesity: Procedure, Benefits and contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.Back pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.

MODULE 2 (6 hours)

Physical fitness a nd exercise:

Meaning and importance of physical fitness and w ellness. Components of physical fitness and health related fitness. Exercise for improving speed, strength, endurance, and flexibility and co ordinative abilities.Exercises to prevent back pain, tennis elbow, shoulder injury and knee pain, Neck pain.Fitness test battery for speed, strength, endurance, flexibility.Importance of weight training.Warming up and cooling down.How to deal with every day stress.

MODULE 3 (6 hours)

First aid:

First aid and principles of first a id.First a id m easure f or t he f ollowing: B leeding through Nose, Snakebite, Dog Bite, Electric Shock, Burns and Drowning.Common injuries and their management: Wounds, Cuts, Sprain, Fracture and Dislocation. Cardio Pulmonary Resuscitation (CPR).How to prevent muscle cramps and its management.How to carry an injured person.

MODULE 4 (6 hours)

Postures and nutrition:

Posture and its importance.Common Postural Deformities-Knock Knee, Flat Foot, Round Shoulders, Lordosis, Kyphosis, Bow Legs and Scoliosis.Corrective Measures for Postural Deformities. Balanced diet, malnutrition and Deficiency diseases. Hydration

Text Books

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light on Yoga by B.K.S. Iyengar.
3. Health and Physical Education- NCERT (11th and 12th Classes)

Reference Books

4. Physiological aspects of sports training and performance by Jay Hoffman.
5. Periodization theory and methodology of training by Tudor O Bompa and G Grisgery Haff.
6. Essential of strength training and conditioning by Thomas Baechle E R, Roger W Earle.
7. A practice guide to emergency first aid, safety injuries, illnesses by Montreal.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Total Hours	24 Hours
	Module 1	6
1.1	Meaning and importance of Yoga.Introduction-Asanas, Pranayama, Meditation and Yogic Kriyas.Yoga for concentration and related Asanas (Sukhasana; Tadasana; Padmasana and Shashankasana) Relaxation Techniques for improving concentration-Yog-nidra. Asanas as preventive measures.	2
1.2	Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.	1
1.3	Obesity: Procedure, Benefits and contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.	1

1.4	Back pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana	2
	Module 2	6
2.1	Meaning and importance of physical fitness and wellness, Components of physical fitness and health related fitness	1
2.2	Exercise for improving speed, strength, endurance, and flexibility and co ordinative abilities	1
2.3	Exercises to prevent back pain, shoulder injury and knee pain.	2
2.4	Fitness test battery for speed, strength, endurance, flexibility.	1
2.5	Importance of weight training, Warming up and cooling down.	1
	Module 3:	6
3.1	First aid and principles of first aid.First aid measure for the following: Bleeding through Nose, Snakebite, Dog Bite, Electric Shock, Burns and Drowning.	2
3.2	Common injuries and their management: Wounds, Cuts, Sprain, Fracture and Dislocation	2
3.3	Cardio pulmonary resuscitation (CPR).	1
3.4	How to prevent muscle cramps and its management.How to carry an injured person	1
	Module 4:	6
4.1	Posture and its importance.Common Postural Deformities-Knock Knee, Flat Foot, Round Shoulders.	2
4.2	Lordosis, Kyphosis, Bow Legs and Scoliosis.Corrective Measures for Postural Deformities.	2
4.3	Balanced diet, malnutrition and deficiency disease, Hydration.	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Demonstrate yoga asanas for life style problems
2. Create a PPT presentation on various yoga asanas
3. Group Activity - Group discussion about the need and benefits of physical activities and Yoga for the strength, flexibility, and relaxation of mind and body.

Course Outcome 2 (CO 2):

1. Analyze the exercise activities of at least five famous personalities and give a PPT presentation about how each one of them uses physiological principles related to exercise and training in daily routine.

2. Conduct a survey on how the following categories of people follow physiological principles related to exercise and training in daily routine.

   (a) Sports person
   (b) Working woman
   (c) Students
   (d) Ladies in the age group of 25-35, 35-45,45- 55,55-65, above 65
   (e) Gents in the age group of 25-35, 35-45,45- 55,55-65, above 65

Course Outcome 3 (CO 3):

With a role play, illustrate various first aid activities that can be followed at various situation in life. In each illustration, try to give emphasis on dos and don'ts to be followed in each situation.

Course Outcome 4 (CO 4):

Observe at least 10 students in your class and identify common postural deformities each one of them have. Also identify good posters they follow. Have a discussion with each one of them to identify whether they have already recognized it or not. Prepare a report on this including your thoughts on the diet they take and its impact on their health.

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 2

SYLLABUS

B24MA1T02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORMS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble:

This course introduces the concepts and applications of differential equations, sequence and series including power series and basic transforms such as Laplace and Fourier transforms. The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include differential equations, sequence, series and transforms. The topics treated in this course have applications in all branches of engineering.

Prerequisites: Nil

Course Outcomes:

After the completion of the course the student will be able to:

CO 1	Solve homogeneous and non-homogeneous linear differential equation with constant coefficients (Cognitive Knowledge Level: Apply)
CO 2	Perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent (Cognitive Knowledge Level: Apply)
CO 3	Determine the Taylor and Fourier series expansion of functions and learn their applications. (Cognitive Knowledge Level: Apply)
CO 4	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering (Cognitive Knowledge Level: Apply)
CO 5	Compute Laplace transform and apply them to solve ordinary differential equations arising in engineering (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2	1		1							1
CO 2	3	2	1		1							1
CO 3	3	2	1		1							1
CO 4	3	2	1		1							1
CO 5	3	2	1		1							1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

MODULE 1 (Ordinary Differential Equations)

(Text 2: Relevant topics from sections 2.1, 2.2, 2.5,2.6, 2.7, 2.10, 3.1, 3.2, 3.3)

Homogenous linear differential equation of second order, superposition principle, general solution, homogenous linear ODEs with constant coefficients-general solution. Solution of Euler-Cauchy equations (second order only). Existence and uniqueness (without proof). Non homogenous linear ODEs-general solution, solution by the method of undetermined coefficients(for the right hand side of the form x^n,e^{kx},$sinax$, $cosax$ and their linear combinations) , methods of variation of parameters. Solution of higher order equations-homogeneous and non-homogeneous with constant coefficients using method of undetermined coefficients.

MODULE 2 (Sequences and Series)

(Text 1: Relevant topics from sections 9.1, 9.3, 9.4, 9.5, 9.6)

Convergence of sequences and series, convergence of geometric series and p-series (without proof), tests of convergence (comparison, limit comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.

MODULE 3 (Fourier Series)

(Text 1: Relevant topics from sections 9.8, 9.9. Text 2: Relevant topics from sections 11.1, 11.2, 11.6)

Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formula, Convergence of Fourier series (without proof), half range sine and cosine series.

MODULE 4 (Fourier Transforms)

(Text 2: Relevant topics from sections 11.7, 11.8, 11.9)

Fourier integral representation, Fourier sine and cosine integrals. Fourier sine and cosine transforms, inverse sine and cosine transform. Fourier transform and inverse Fourier transform, basic properties. The Fourier transform of derivatives. Convolution theorem (without proof).

MODULE 5 (Laplace Transforms)

(Text 2: Relevant topics from sections 6.1, 6.2 ,6.3, 6.4, 6.5)

Laplace Transform and its inverse, Existence theorem (without proof), linearity, Laplace transform of basic functions, first shifting theorem, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function, Second shifting theorem. Dirac delta function and its Laplace transform, Solution of ordinary differential equation involving unit step function and Dirac delta functions. Convolution theorem (without proof) and its application to finding inverse Laplace transform of products of functions.

Text Books

1. H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10^{th} edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10^{th} edition, John Wiley& Sons, 2016.

Reference Books

1. J. Stewart, "Essential Calculus", Cengage,2^{nd} edition, 2017.
2. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9^{th} Edition, Pearson, Reprint,2002.
3. Peter O Neil, "Advanced Engineering Mathematics", 7^{th} Edition, Thomson, 2007.
4. Louis C Barret, C Ray Wylie, "Advanced Engineering Mathematics", Tata McGraw Hill, 6^{th} edition, 2003.
5. Veerarajan T,"Engineering Mathematics for first year", Tata McGraw - Hill, 2008.
6. B.S. Grewal,"Higher Engineering Mathematics", Khanna Publishers, 43 Edition, 2015.
7. Ronald N. Bracewell, "The Fourier Transform and its Applications", McGraw – Hill International Editions, 2000.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
1	**Module 1: Ordinary Differential Equations**	9
1.1	Homogenous linear equation of second order, Superposition principle, general solution.	1
1.2	Homogenous linear ODEs of second order with constant coefficients.	2
1.3	Second order Euler-Cauchy equation.	1
1.4	Non homogenous linear differential equations of second order with constant coefficient-solution by undetermined coefficients, variation of parameters.	3
1.5	Higher order equations with constant coefficients.	2
2	**Module 2: Sequences and Series**	9
2.1	Convergence of sequences and series, geometric and p-series.	2
2.2	Test of convergence (comparison, ratio and root).	4

2.3	Alternating series and Leibnitz test, absolute and conditional convergence	3
3	**Module 3: Fourier series**	9
3.1	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions.	3
3.2	Fourier series, Euler formulas, Convergence of Fourier series (Dirichlet's conditions)	3
3.3	Half range sine and cosine series.	3
4	**Module 4: Fourier Transforms**	9
4.1	Fourier integral representation.	1
4.2	Fourier Cosine and Sine integrals and transforms.	2
4.3	Complex Fourier integral representation, Fourier transform and its inverse transforms, basic properties.	3
4.4	Fourier transform of derivatives, Convolution theorem	3
5	**Module 5: Laplace Transforms**	9
5.1	Laplace Transform , inverse Transform, Linearity, First shifting theorem, transform of basic functions.	2
5.2	Transform of derivatives and integrals.	1
5.3	Solution of Differential equations, Initial value problems by Laplace transform method.	2
5.4	Unit step function - Second shifting theorem.	1
5.5	Dirac Delta function and solution of ODE involving Dirac delta function.	2
5.6	Convolution and related problems.	1
	Total	**45 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1): Solve homogeneous and nonhomogeneous linear equation with constant coefficients.

1. Find the general solution to $2x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - 3y = 0$ given that $y_1(x) = \frac{1}{x}$ is a solution.
2. Solve the initial value problem $x^2y^{''} - 3xy^{'} + 4y = 0$ given that $y(1) = \pi, y^{'}(1) = 4\pi$
3. By the method of undetermined coefficients, solve $y^{''} - 2y^{'} + y = e^x cos2x$

Course Outcome 2 (CO 2): Perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent.

1. Find the sum of the series $\sum_{n=1}^{\infty} \frac{1}{9n^2+3n-2}$,if it is convergent.
2. Examine the convergence of $\sum_{n=1}^{\infty} \left(\frac{n}{n+1}\right)^{n^2}$

3. Determine whether the series $\sum_{n=1}^{\infty} \frac{(-1)^n n^4}{4^n}$ is absolutely convergent.

Course Outcome 3 (CO 3): Determine the power series expansion of a given function.

1. Find the Taylor's series representation of $f(x) = sin\pi x$ about $x = 1$
2. Determine the binomial series representation of $\frac{1}{\sqrt{(2+x)^3}}$
3. Find the Fourier series of the periodic function $f(x)$ of period 2, where $f(x) = \begin{cases} -1 & -1 \leq x \leq 0 \\ 2x & 0 \leq x \leq 1 \end{cases}$ and deduce that $1 + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^2}{8}$.

Course Outcome 4 (CO 4): Determine the Fourier transforms of functions and apply them to solve problems arising in engineering .

1. Find the Fourier integral representation of function defined by $f(x) = e^{-x}$ for $x > 0$ and $f(x) = 0$ for $x < 0$.
2. What are the conditions for the existence of Fourier Transform of a function $f(x)$?
3. Find the Fourier Transform of $f(x) = x$ for $|x| \leq 1$ and $f(x) = 0$ otherwise.

Course Outcome 5 (CO 5):Compute Laplace transform and apply them to solve ODEs arising in engineering.

1. What is the inverse Laplace Transform of $\frac{3s+2}{(s-1)(s^2+2s+5)}$
2. Find Laplace Transform of (i) $e^{-t}sin^2t$ (ii) $\delta(t-a)$
3. Solve the differential equation $y'' + 4y = f(t), y(0) = 1, y'(0) = 0$ where $f(t) = \begin{cases} 0 & \text{if } 0 \leq t \leq 4 \\ 3 & \text{if } t \geq \pi \end{cases}$

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24MA1T02

Course Name: ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORMS
Common to all branches

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Check whether x, lnx are linearly independent or not.
2. Solve $y''' + 9y' = 0$.
3. Find the rational number represented by the repeating decimal 5.373737...
4. Examine the convergence of $\sum_{k=1}^{\infty} \frac{1}{k!}$
5. Find the binomial series for $f(x) = (1+x)^{\frac{1}{3}}$ upto third degree term.
6. Obtain the half range sine series expansion of $f(x) = \pi x - x^2$ in $(0, \pi)$.
7. Find the cosine integral representation of the function $f(x) = \begin{cases} 1 & ; 0 < x < 1 \\ 0 & ; x > 1 \end{cases}$
8. Find the Fourier cosine transform of e^{-x} , $x > 0$.
9. Find the Laplace transform of $sin^2 2t$.
10. Find $L^{-1}\left\{\frac{1}{(s-1)(s-2)}\right\}$.

PART B

Answer any one question from each module. Each question carries 14 marks.

11. (a) Solve the initial value problem $y'' + 9y = 0, y(0) = 0.2, y'(0) = -1.5$. 7

(b) By the method of variation of parameters solve $y'' + 4y = tan2x$. 7

OR

12. (a) By the method of undetermined coefficients solve $y'' + 2y' + 4y = 3e^{-x}$. 7

(b) Solve $x^2y'' + xy' + 9y = 0, y(1) = 0, y'(1) = 2.5$.

7

13. (a) Test the convergence of (i) $\sum_{k=1}^{\infty} \frac{3k^3-2k^2+4}{k^7-k^3+2}$ (ii) $\sum_{k=1}^{\infty} \frac{k^k}{k!}$. 7

(b) Check the convergence of the series $1 + \frac{1.3}{3!} + \frac{1.3.5}{5!} + \frac{1.3.5.7}{7!} + \ldots$ 7

OR

14. (a) Determine whether the series $\sum_{k=1}^{\infty} \frac{1}{\sqrt{k+1}}$ is absolutely convergent or conditionally convergent. 7

(b) Test the convergence of (i)$\sum_{k=1}^{\infty} \frac{k!}{3!(k-1)!3^k}$ (ii) $\sum_{k=1}^{\infty} (\frac{4k-5}{2k+1})^k$ 7

15. (a) Expand into a Fourier series , $f(x) = e^{-x}, 0 < x < 2\pi$. 7

(b) Obtain the half range Fourier sine series of $f(x) = \begin{cases} x & ,0 < x < \frac{\pi}{2} \\ \pi - x & ,\frac{\pi}{2} < x < \pi \end{cases}$ 7

OR

16. (a) Find the Fourier series expansion of $f(x) = x^2$ in the interval $-\pi < x < \pi$. Hence show that $1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots = \frac{\pi^2}{12}$. 7

(b) Find the half range cosine series for $f(x) = (x-1)^2$in $0 \leq x \leq 1$. 7

17. (a) Find the Fourier transform of $f(x) = \begin{cases} 1 & \text{if } |x| < 1 \\ 0 & \text{otherwise} \end{cases}$ 7

(b) Find the Fourier sine integral of $f(x) = \begin{cases} sinx & ,0 \leq x \leq \pi \\ 0 & ,x > \pi \end{cases}$ 7

OR

18. (a) Using Fourier integral representation show that $\int_0^{\infty} \frac{coswx}{1+w^2} dw = \frac{\pi}{2}e^{-x}, x > 0$. 7

(b) Find the Fourier sine transform of $f(x) = \begin{cases} k & ,0 < x < a \\ 0 & ,x > a \end{cases}$ 7

19. (a) Find the Laplace transform of (i) $tsin2t$ (ii) $e^{-t}sin3tcos2t$ 7

(b) Using convolution theorem find $L^{-1}\left\{\frac{1}{s(s^2+4)}\right\}$ 7

OR

20. (a) Find $L^{-1}\left\{\frac{4s+5}{(s+2)(s-1)^2}\right\}$ 7

(b) Use Laplace transform to solve $y'' + 2y' + 2y = 0, y(0) = y'(0) = 1$. 7

B24PH1T01B	ENGINEERING PHYSICS (B)	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble

The aim of this course is to equip students with a solid foundation in physics principles and knowledge of their engineering applications. This will enhance the students' ability to analyze and solve complex engineering problems. Ultimately, the goal is to produce graduates who are well prepared to tackle real world engineering challenges with a deep understanding of the underlying physical principles.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Analyze the phenomenon of oscillations and quantify the distinction between undamped, damped and forced oscillations. (Cognitive Knowledge Level: Apply)
CO 2	Apply laws of Physics in the design and analysis of different types of sensors. (Cognitive Knowledge level: Apply)
CO 3	Understand the different types of chemical bonds, the concept of dislocations in materials and their influence on the mechanical properties of materials. (Cognitive Knowledge level: Apply)
CO 4	Quantify architectural and acoustic characteristics of buildings, gain familiarity with the principles and applications of ultrasonic testing for flaw detection and the design of ultrasonic transducers and systems. (Cognitive Knowledge level: Apply)
CO 5	Understand the principle and structure of lasers and the working of optical fibers. (Cognitive Knowledge level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	1								1
CO 2	3	1	2	1								1
CO 3	3	1		1								1
CO 4	3	2	2	1								1
CO 5	3	1	1	1			1					1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 Marks
Continuous Assessment Test (2 numbers)	25 Marks
Assignment/Quiz/Course Project	15 Marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

MODULE 1 (7 hours)

Oscillations:

Simple Harmonic Oscillator - differential equation, solution - torsion pendulum Damped harmonic oscillator - differential equation and solution (underdamped case), comparison with undamped harmonic oscillator, logarithmic decrement, relaxation time, Q factor, Forced

Harmonic Oscillator - differential equation and its solution, Analysis of the solution - amplitude resonance

MODULE 2 (8 hours)

Sensors:

Sensors - Introduction and classification, Sensor characteristics (definition only): Static characteristics - transfer function - sensitivity, calibration - calibration error, hysteresis, resolution, output impedance; Dynamic characteristics - zero order, first order and second order sensors (qualitative ideas only)
Sensor elements (principle of working and operation): Resistive elements - Potentiometric measurement of linear and angular displacement, resistive strain gauge; Capacitive elements - capacitive sensor architectures, capacitive displacement and liquid level sensors; Inductive elements - LVDT; Hall effect sensors

MODULE 3 (8 hours)

Bonding in Materials:

Ionic, Covalent, Metallic and Van der Waals bonding; Bonding Energy.Crystalline State - crystal planes and directions - Miller indices, Defects in Crystals - zero, one and two dimensional defects, Grain Boundaries. Movement of atoms - Slip Along Atomic Planes - Dislocation Movement - edge and screw dislocations, Burger vector, Solid state Diffusion - Fick's Laws

MODULE 4 (7 hours)

Acoustics & Ultrasonics:

Acoustics - Characteristics of Sound waves - Pitch, Loudness - Decibel, Absorption coefficient, Reverberation - Reverberation time - Significance, Sabine's formula and applications. Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator – Working, Applications - SONAR, NDT

MODULE 5 (6 hours)

Laser & Fibre Optics:

Optical processes - Absorption, Spontaneous emission and stimulated emission, - Einstein's relations. Principle of laser - conditions for sustained lasing - components of laser - Population inversion - energy source - Pumping, Metastable states - active medium, optical resonator. Construction and working of Ruby laser.
Optic fiber-Principle of propagation of light, Numerical aperture – Derivation Applications of fibers - Intensity modulated sensors.

Text Books

1. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
2. M.N. Avadhanulu, P.G. Kshirsagar, TVS Arun Murthy, "A Textbook of Engineering Physics", S.Chand & Co., Revised Edition, 2019.
3. James F. Shackelford, "Introduction to Material Science for Engineers", Pearson, Eighth Edition, 2015.
4. Jacob Fraden, "Handbook of Modern Sensors - Physics, Designs, and Applications", Springer, Fourth Edition, 2010.
5. John P. Bentley, "Principles of Measurement Systems", Pearson Education Limited, Fourth Edition, 2005.

Reference Books

1. Arthur Beiser, "Concepts of Modern Physics ", Tata McGraw Hill Publications, 6th Edition 2003
2. D.K. Bhattacharya, Poonam Tandon, "Engineering Physics", Oxford University Press, 2015
3. Md.N.Khan & S.Panigrahi "Principles of Engineering Physics 1&2", Cambridge University Press, 2016
4. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
5. Ajoy Ghatak, "Optics", McGraw Hill Education, Sixth Edition, 2017

COURSE CONTENTS AND LECTURE SCHEDULE

No	**Topic**	**No of Lecture/Tutorial Hours**
	Total Hours	36 Hours
	Module 1: Oscillations	7
1.1	Simple Harmonic Oscillator - differential equation, solution - torsion pendulum	3
1.2	Damped harmonic oscillator - differential equation and solution (underdamped case), comparison with undamped harmonic oscillator, logarithmic decrement, relaxation time, Q factor	2

1.3	Forced Harmonic Oscillator - differential equation and its solution, Analysis of the solution - amplitude resonance	2
	Module 2: Sensors	8
2.1	Sensors - Introduction and classification, Sensor characteristics (definition only): Static characteristics - transfer function - sensitivity, calibration - calibration error, hysteresis, resolution, output impedance; Dynamic characteristics - zero order, first order and second order sensors (qualitative ideas only)	2
2.2	Sensor elements (principle of working and operation): Resistive elements - Potentiometric measurement of linear and angular displacement, resistive strain gauge; Capacitive elements - capacitive sensor architectures, capacitive displacement and liquid level sensors; Inductive elements - LVDT; Hall effect sensors	6
	Module 3: Bonding in Materials	8
3.1	Bonding in materials - Ionic, Covalent, Metallic and Van der Waals bonding; Bonding Energy	2
3.2	Crystalline State - crystal planes and directions - Miller indices, Defects in Crystals - zero, one and two dimensional defects, Grain Boundaries	3
3.3	Movement of atoms - Slip Along Atomic Planes - Dislocation Movement - edge and screw dislocations, Burger vector, Solid state Diffusion - Fick's Laws	3
	Module 4: Acoustics & Ultrasonics	7
4.1	Acoustics - Characteristics of Sound waves - Pitch, Loudness - Decibel, Absorption coefficient, Reverberation - Reverberation time - Significance, Sabine's formula and applications	3
4.2	Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator – Working, Applications - SONAR, NDT	4
	Module 5: Laser & Fibre Optics	6
5.1	Optical processes - Absorption, Spontaneous emission and stimulated emission - Einstein's relations	1
5.2	Principle of laser - conditions for sustained lasing - components of laser - Population inversion - energy source - Pumping, Metastable states - active medium, optical resonator	2
5.3	Construction and working of Ruby laser	1
5.4	Optic fibre-Principle of propagation of light, Numerical aperture – Derivation	1
5.5	Applications of fibres - Intensity modulated sensors	1

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Define SHM.
2. Define Q factor of a DHO.
3. Explain amplitude resonance.

Course Outcome 2 (CO 2):

1. List the dynamic characteristics of a sensor.
2. Explain the working of a Hall Effect sensor.
3. What is an LVDT?

Course Outcome 3 (CO 3):

1. Differentiate between covalent, metallic and Van der Waal bonding.
2. State Fick's Laws governing solid state diffusion.
3. Describe Edge dislocation.

Course Outcome 4 (CO 4):

1. Write Sabine's formula.
2. What is the change in dB level when the intensity of a source of sound is doubled?
3. Explain two methods of ultrasonic NDT.

Course Outcome 5 (CO 5):

1. Describe the principle of LASER.
2. Why are metastable levels needed in a LASER?
3. Write a note on intensity modulated sensors.

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2024

Course Code: B24PH1T01B

Course Name: ENGINEERING PHYSICS (B)

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Derive the differential equation of a DHO.
2. Define Q factor. What are the factors on which it depends?
3. Differentiate between first order and second order sensors.
4. Explain transfer function, sensitivity and calibration error of a sensor.
5. Explain edge and screw dislocations.
6. State Fick's Laws of solid state diffusion.
7. Differentiate between reverberation and echo.
8. Mention any three applications of ultrasonics.
9. Explain the term population inversion.
10. Describe the principle of operation of optic fibers.

PART B

Answer any one question from each module. Each question carries 14 marks.

11. (a) Derive the differential equation of an FHO. Obtain the expression for the amplitude of forced oscillations. 10

    (b) The amplitude of an underdamped harmonic oscillation reduces to $\frac{1}{10}^{th}$ of its initial value after 100 oscillations. Its time period is 1.15s. Calculate its relaxation time. 4

OR

12. (a) Frame and solve the differential equation of a DHO and find the solution for the overdamped case. Show graphically the variation of its displacement with time. 10

    (b) DHO of mass 2g has a force constant of 10Nm^{-1} and a damping constant of 2s^{-1}. Find the angular frequency with and without damping. 8

13. (a) Explain any six static characteristics of a sensor. 6

    (b) With the help of a neat diagram, explain the working of a Hall Effect sensor. 8

OR

14. (a) Explain the dynamical characteristics of a sensor. 6

    (b) Explain, with the help of a neat schematic diagram, the working of a resistive strain gauge. 8

15. (a) Explain the terms defects, slip and dislocation movements in crystals. 8

    (b) Explain solid state diffusion. State Fick's Laws. 6

OR

16. (a) Explain the classification of materials based on the bonding. What are the bonding energies in each case? 10

    (b) Calculate the Miller indices of a plane whose intercepts are a, b2 and con the crystallographic axes respectively in a simple cubic cell. 4

17. (a) Derive Sabine's formula and explain its applications. 10

    (b) A hall has a volume of 1000m3 and a total absorption equivalent to 100m2 of OWU. What will be the effect on its reverberation time if the audience fills the hall thereby increasing the absorption by 150m2 of OWU? 4

OR

18. (a) Explain piezoelectric effect and the working of a piezoelectric ultrasonic generator. 10

    (b) A quartz crystal of thickness 1mm vibrates at resonance. Calculate its fundamental frequency if its Young's modulus is $7.96\times10^{9}Nm^{-2}$ and density is 2670 kgm^{-3}. 4

19. (a) Explain the construction and working of Ruby laser. 10

    (b) Describe shortly the main components of a laser system. 4

OR

20. (a) Derive the expression for the Numerical Aperture of an optic fiber. 10

    (b) Calculate the N.A. of an optic fiber having core index of 1.54 and cladding index of 1.5. 4

B24CY1T01A	ENGINEERING CHEMISTRY (A)	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble:
This basic science course will assist the students to acquire understanding in the concepts of chemistry for engineering applications and to familiarize the students with different application oriented topics like electrochemistry, nanomaterials, energy production, energy storage, OLED etc. Moreover, the students will be able to know analytical methods like various spectroscopic techniques, SEM etc. This will empower them to develop abilities and skills that are relevant to the study and practice of chemistry in their respective field of engineering.

Prerequisites: NIL

Course Outcomes:

After the completion of the course the student will be able to:

CO 1	Develop a comprehensive understanding of nanoscale materials, including their synthesis, fundamental properties and diverse applications. (Cognitive Knowledge Level: Apply)
CO 2	Understand the principles and applications of various spectroscopic techniques and microscopic techniques such as SEM. (Cognitive Knowledge Level: Apply)
CO 3	Demonstrate an inclusive understanding of the principles of electrochemistry and corrosion. Also gain knowledge about various corrosion control methods. (Cognitive Knowledge Level: Apply)
CO 4	Learn about the basics of energy harvesting methods and its application. Apply the knowledge of battery, hydrogen generation and fuel cells in engineering. (Cognitive Knowledge Level: Apply)
CO 5	Apply the knowledge of conducting polymers and advanced materials in engineering. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	2	1	2	2	1	1	2					1
CO 2	1	2	2	1	2		2					1
CO 3	3	2	3	1	2	2	1					2
CO 4	3	2	3	2	3	3	3	1	1			2
CO 5	2	1	3	1	3	1	2	1				2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

MODULE 1 (7 hours)

Fundamentals of Nanomaterials

Introduction - Classification - Based on dimension and structural composition - Nanoscale materials – Introduction - Properties and applications of Quantum dots, Graphene and Carbon nanotubes (CNT) – General Properties and applications of nanomaterials - Synthesis of nanomaterials – Top-Down and Bottom-Up approaches – Physical methods of synthesis

- Mechanical milling, Laser ablation and Sputtering - Chemical methods of synthesis – Sol-Gel, co-precipitation and reduction.

MODULE 2 (8 hours)

Spectroscopic and Microscopic Techniques

Introduction - Types of spectrum - Electromagnetic spectrum - Molecular energy levels - Beer-Lambert's law – Numerical problems based on Beer-Lambert's law - Electronic spectroscopy (UV-vis) – Principle, instrumentation and applications - Types of electronic transitions - Vibrational spectroscopy (IR) – Principle and applications - Number of vibrational modes - Vibrational modes of CO_2 and H_2O – Force constant equation for diatomic molecules - Numerical problems based on force constant - Microscopic techniques - Scanning Electron Microscope (SEM) - Principle, instrumentation, working and applications.

MODULE 3 (7 hours)

Introduction to Electrochemistry and Corrosion Science

Introduction - Reference electrodes - Calomel electrode - Construction and working - Electrochemical series - Applications – Nernst equation for single electrode and cell (Derivation not required) – Applications – Effect of temperature on emf - Numerical problems based on Nernst equation - Corrosion – Introduction - Galvanic series - Types of corrosion – Galvanic and pitting corrosion - Corrosion control methods - Cathodic protection - Sacrificial anodic protection and impressed current cathodic protection – Electroplating of Copper - Electroless plating of Copper – Anodizing of Aluminium.

MODULE 4 (7 hours)

Energy Storage and Harvesting Technologies

Cells and batteries – Primary and secondary cells – Na-ion battery and Li-ion battery - Construction, working, advantages and applications – Hydrogen generation – Electrolysis of water - Fuel cells – Introduction - Construction and advantages of H_2-O_2 fuel cell, Phosphoric acid fuel cell and Polymer Electrolyte Membrane Fuel Cell (PEMFC) - Supercapacitors - Classification - Construction and applications in hybrid vehicles.

MODULE 5 (7 hours)

Advanced Materials and Devices for Engineering Applications

Conducting polymers – Introduction - Classification - Intrinsically and extrinsically conducting polymers - Conduction mechanism – Band theory - Polyaniline and polypyrrole - Synthesis, properties and applications – Molecular devices based on conducting polymers – Diodes, Field Effect Transistor and Actuators - Introduction and applications - OLED

– Construction, working and advantages - Smart materials - Thermo and light responsive materials - Introduction and examples - Sensors – Physical, chemical and biosensors – Introduction and applications.

Text Books

1. Jain and Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 17^{th} edition 2015.
2. Shashi Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai and Co. (P) Limited, 2017.
3. Muhammed Arif, Annette Fernandez, Kavitha P. Nair, "Engineering Chemistry", Owl Books, 2019.
4. Ahad J., "Engineering Chemistry", Jai Publication, 2019.
5. Roy K. Varghese, "Engineering Chemistry", Crown Plus Publishers, 2019.
6. Soney C. George, Rino Laly Jose, "Text Book of Engineering Chemistry", S. Chand and Company Pvt. Ltd., 2019.
7. B. L. Tembe, Kamaluddin, M. S. Krishnan, "Engineering Chemistry (NPTEL Web Book)", 2018.

Reference Books

1. T. Pradeep, "NANO: The Essentials: Understanding Nanoscience and Nanotechnology", McGraw-Hill, 2008.
2. B. Rogers, J. Adams, S. Pennathur, "Nanotechnology: Understanding Small Systems" , CRC Press, 2014.
3. Donald L. Pavia, "Introduction to Spectroscopy", Cengage Learning India Pvt. Ltd., 2015.
4. J. Goldstein, "Scanning Electron Microscopy and Microanalysis", Springer, 2012.
5. H. H. Willard, L. L. Merritt, "Instrumental Methods of Analysis", CBS Publishers, 7^{th} Edition, 2005.
6. Samuel Glasstone, "An Introduction to Electrochemistry", East-West Press Pvt. Ltd., 2006.
7. Pietro Pedeferri, "Corrosion Science and Engineering", Springer Link, 2018.
8. B. Sunden, "Hydrogen, Batteries and Fuel Cells", Elsevier Inc., 2019.
9. B. Sorensen and G. Spazzafumo, "Hydrogen and Fuel Cells - Emerging Technologies and Applications", Elsevier Ltd., 2018.
10. Raymond B. Seymour, Charles E. Carraher, "Polymer Chemistry: An Introduction",Marcel Dekker Inc; 4^{th} Revised Edition,1996.

11. J. Janata, "Principles of Chemical Sensors" Springer, New York, NY, 2009.

12. F-G. Banica, "Chemical Sensors and Biosensors: Fundamentals and Applications", John Wiley and Sons, 2012.

13. M. Schwartz, "Smart Materials", CRC Press, 2008.

14. Y. Zhao, T. Ikeda, "Smart Light-Responsive Materials", Wiley, 2009.

15. V. Khutoryanskiy, T. Georgiou, "Temperature-Responsive Polymers: Chemistry, Properties and Applications", Wiley, 2018.

16. P. W. Atkins, "Physical Chemistry", Oxford University Press, 10^{th} edn., 2014.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Total Hours	36 Hours
	Module 1 (Fundamentals of Nanomaterials)	7
1.1	Introduction - Classification - Based on dimension and structural composition.	1
1.2	Nanoscale materials – Introduction - Properties and applications of Quantum dots, Graphene and Carbon nanotubes (CNT) – General properties and applications of nanomaterials.	3
1.3	Synthesis of nanomaterials – Top-Down and Bottom-Up approaches – Physical methods of synthesis - Mechanical milling, Laser ablation and Sputtering - Chemical methods of synthesis – Sol-Gel, co-precipitation and reduction.	3
	Module 2 (Spectroscopic and Microscopic Techniques)	8
2.1	Introduction - Types of spectrum - Electromagnetic spectrum - Molecular energy levels - Beer-Lambert's law – Numerical problems based on Beer-Lambert's law.	3
2.2	Electronic spectroscopy (UV-vis) – Principle, instrumentation and applications - Types of electronic transitions - Vibrational spectroscopy (IR) – Principle and applications - Number of vibrational modes - Vibrational modes of CO_2 and H_2O – Force constant equation for diatomic molecules - Numerical problems based on force constant.	4
2.3	Microscopic techniques - Scanning Electron Microscope (SEM) - Principle, instrumentation, working and applications.	1

	Module 3 (Introduction to Electrochemistry and Corrosion Science)	7
3.1	Introduction - Reference electrodes - Calomel electrode - Construction and working - Electrochemical series - Applications – Nernst equation for single electrode and cell (Derivation not required) – Applications – Effect of temperature on emf - Numerical problems based on Nernst equation.	3
3.2	Corrosion – Introduction - Galvanic series - Types of corrosion – Galvanic and pitting corrosion - Corrosion control methods - Cathodic protection - Sacrificial anodic protection and impressed current cathodic protection.	2
3.3	Electroplating of Copper - Electroless plating of Copper – Anodizing of Aluminium	2
	Module 4 (Energy Storage and Harvesting Technologies)	7
4.1	Cells and batteries – Primary and secondary cells – Na-ion battery and Li-ion battery - Construction, working, advantages and applications.	2
4.2	Hydrogen generation – Electrolysis of water - Fuel cells – Introduction - Construction and advantages of H_2-O_2 fuel cell, Phosphoric acid fuel cell and Polymer Electrolyte Membrane Fuel Cell (PEMFC).	3
4.3	Supercapacitors - Classification - Construction and applications in hybrid vehicles.	2
	Module 5 (Advanced Materials and Devices for Engineering Applications)	7
5.1	Conducting polymers – Introduction - Classification - Intrinsically and extrinsically conducting polymers - Conduction mechanism – Band theory - Polyaniline and polypyrrole - Synthesis, properties and applications.	3
5.2	Molecular devices based on conducting polymers – Diodes, Field Effect Transistors, and Actuators - Introduction and applications - OLED – Construction, working and advantages.	2
5.3	Smart materials - Thermo and light responsive materials - Introduction and examples - Sensors – Physical, chemical and biosensors – Introduction and applications.	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. What are carbon nanotubes? Give two applications.

2. Comment on the structure of graphene.
3. How nanomaterials are classified based on structural composition?

Course Outcome 2 (CO 2):

1. State Beer-Lambert's law.
2. Calculate and sketch the vibrational modes of CO_2.
3. What are the limitations of SEM?

Course Outcome 3 (CO 3):

1. How equilibrium constant is determined using electrochemical series?
2. Write the representation and reactions of calomel electrode.
3. Give any two differences between electrochemical series and galvanic series.

Course Outcome 4 (CO 4):

1. Compare Na-ion and Li-ion batteries.
2. List the applications of PEM fuel cell.
3. Discuss the classification of supercapacitors.

Course Outcome 5 (CO 5):

1. Explain the preparation and properties of polypyrrole.
2. Discuss the working of OLED.
3. Compare physical and chemical sensors.

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24CY1T01A

Course Name: ENGINEERING CHEMISTRY (A)

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Discuss the properties and applications of quantum dots.
2. How carbon nanotubes are classified based on structure?
3. State Beer-Lambert's law.
4. List the important applications of IR spectroscopy.
5. Explain how galvanic series can be used in corrosion control?
6. What is calomel electrode? Give the reduction reaction.
7. How does a PEM fuel cell differ from the other types of fuel cells?
8. Distinguish between primary and secondary cells with examples.
9. Give example and explain the importance of light responsive smart materials.
10. What are biosensors? Give their applications.

PART B

Answer any one question from each module. Each question carries 14 marks.

11. (a) Explain two methods of chemical synthesis for nanomaterials. 8

(b) Discuss the classification of nanomaterials based on dimension. 6

OR

12. (a) What are nanoscale materials? Give the properties and applications of quantum dots and graphene. 9

(b) Explain the sputtering method for the synthesis of nanomaterials. 5

13. (a) Explain the principle, instrumentation and working of SEM. 8

(b) Calculate the force constant of HCl molecule, if it shows IR absorption at 2138 cm^{-1}. Given that atomic masses of hydrogen and chlorine are 1 u and 35 u respectively. 6

OR

14. (a) Illustrate the vibrational modes of CO_2 and H_2O. Justify its IR activity. 9

(b) Explain the various energy levels associated with a molecule. 5

15. (a) How electroless plating of copper is carried out? Give the procedure and reactions. 8

(b) Write the cell reactions and calculate the emf of the cell Cu/Cu^{2+} (1M) // Ag^+ (0.01M) // Ag at 30^oC. Given E^0 Cu^{2+}/Cu = 0.34 V and E^0 $Ag^+/Ag = 0.8V$. 6

OR

16. (a) What is cathodic protection? Explain two methods. 9

(b) Write the Nernst equation for Daniel cell and explain the effect of temperature on emf. 5

17. (a) Discuss the construction, working and advantages of Li-ion battery. 9

(b) What is electrolysis of water? 5

OR

18. (a) With a neat diagram explain the construction and working of Hydrogen-Oxygen fuel cell. 8

(b) Explain the classification of supercapacitors. 6

19. (a) Discuss the construction and working of OLED with a diagram. 9

(b) Explain the synthesis, properties and applications of polyaniline. 5

OR

20. (a) Elaborate the classification and applications of conducting polymers. 8

(b) What are smart materials? Give examples for heat responsive materials. 6

B24ES1T08	FUNDAMENTALS OF ELECTRONICS ENGINEERING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble

This course is designed to give an overview of the evolution of electronics and to explain the working principles and examples of essential electronic devices and circuits. It also aims to introduce students to the basics of signal processing and provide an introduction to digital electronics.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Identify the active and passive electronic components and their specifications. (Cognitive Knowledge Level-Remember).
CO 2	Understand the working principle of semiconductor devices and Analyze different types of rectifier circuits (Cognitive Knowledge Level-Apply).
CO 3	Comprehend the structure and operation of bipolar junction transistors and Explain the working principle of amplifiers (Cognitive Knowledge Level-Understand).
CO 4	Identify and describe the basic functions and types of operational amplifiers filters, and signal converters (Cognitive Knowledge Level-Apply).
CO 5	Demonstrate proficiency in electronic instrumentation and digital electronics (Cognitive Knowledge Level-Understand).

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1								1
CO 2	3	2	2	2								1
CO 3	3	2	2	2								1
CO 4	3	2	2	2								1
CO 5	3	2	2	2								1

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (%Marks)	**Test 2 (%Marks)**	
Remember	30	30	30
Understand	50	50	50
Apply	20	20	20
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module) of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which the student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (7 hours)

Introduction to Electronics Components :
Passive components: Resistors - Types of resistors - Fixed Resistors - Variable resistors, resistor tolerance, colour coding, power rating of resistors.
Capacitors: Types of capacitors: Fixed capacitors, Mica, Paper, Ceramic and Electrolytic capacitors, Variable capacitors, voltage rating of capacitors.
Inductors: Fixed and Variable inductors. Transformers, and Electro-mechanical components.

MODULE 2 (8 hours)

Introduction to Semiconductor devices and circuits:
Working of PN Junction diode: Structure and Principle of Operation, V-I Characteristics, Diode Current Equation
Rectifiers: Half wave, full wave, Bridge circuits,
DC Power supply: Block diagram, Capacitor filter, simple Zener regulator.

MODULE 3 (8 hours)

Basics of Semiconductor Devices and Circuits :
Bipolar junction Transistor: NPN, PNP Structure, Principle of operation of NPN transistor
Transistor circuits: Common Emitter Configuration Characteristics
Basic principle of N channel FET and Enhancement MOSFET
Amplifiers, common emitter RC coupled amplifier, Frequency response, Bandwidth.

Analogue Integrated Circuits: Operational amplifier, inverting and non-inverting amplifier (No Analysis required)

MODULE 4 (7hours)

Basics of Signal Processing :
Operational amplifier, inverting and non-inverting amplifier -Open loop and closed loop response (no analysis required)

Filters- Active and passive filters-RC passive filter -Low pass-high Pass-First order active filter- Low pass-high pass (no analysis required)
Concept of ADC- flash type-DAC-Weighted network

MODULE 5 (6 hours)

Basic instrumentation and Digital electronics:
Electronic instrumentation: Transducers: Basic principles of Strain gauge, LVDT, Thermistor, Photodiode, microphones, Loud speaker.
Measurements: Multimeter and X-Y recorder.
Digital electronics: number systems - binary, octal and hexadecimal - conversion - representation of negative numbers using 1's compliment and 2's compliment method. Logic gates – truth table.

Text Books

1. Bell, D. A., Electronic Devices and Circuits, Oxford University Press
2. Chimney Saha, Arindham Halder and Debarati Ganguly, Basic Electronics - Principles and Applications, Cambridge University Press, 2018.
3. S.Sukhija and T.K.Nagsarkar, Basic Electrical and Electronics Engineering, Oxford University Press, 2012.
4. Wayne Tomasi and Neil Storey, A Textbook on Basic Communication and Information Engineering, Pearson, 2010
5. Ramakant A. Gayakwad ,Op-Amps and Linear Integrated Circuits, Pearson Education ,Fourth Edition

Reference Books

1. Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education, 2015.
2. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, 2005.
3. Bernard Grob, Basic Electronics, McGraw Hil
4. A. Bruce Carlson, Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, Tata McGraw Hill, 5th Edition.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Module 1: Introduction to Electronics Components	**7**
1.1	Passive components: Resistors - Types of resistors - Fixed Resistors - Variable resistors, resistor tolerance, color coding, power rating of resistors	3
1.2	Capacitors: Types of capacitors: Fixed capacitors, Mica, Paper, Ceramic and Electrolytic capacitors, Variable capacitors, voltage rating of capacitors.	2
1.3	Inductors: Fixed and Variable inductors. Transformers, and Electro-mechanical components	2
	Module 2:Introduction to Semiconductor devices and circuits	**8**
2.1	Working of PN Junction diode: Structure and Principle of Operation	2
2.2	V-I Characteristics, Diode Current equation	1
2.3	Rectifiers: Half wave, full wave, Bridge circuits,	3
2.4	DC Power supply: Block diagram, Capacitor filter, simple Zener regulator,	2
	Module 3: Basics of Semiconductor Devices and Circuits	**8**
3.1	Bipolar junction Transistor: NPN , PNP Structure, Principle of operation of NPN transistor	2
3.2	Transistor circuits: Common Emitter Configuration Characteristics	1
3.3	Basic principle of N channel FET and Enhancement MOSFET	1
3.4	Amplifiers, common emitter RC coupled amplifier, Frequency response, Bandwidth.	2
3.5	Analogue Integrated Circuits: Operational amplifier, inverting and non-inverting amplifier (No Analysis required)	2
	Module 4: Basics of Analog Circuits and Signal Processing	**7**
4.1	Operational amplifier, inverting and non-inverting amplifier (No Analysis required)-Open loop and closed loop response (no analysis required)	3
4.2 4.3	Filters- Active and passive filters-RC passive filter -Low pass-high Pass-First order active filter- Low pass-high pass (no analysis required) Concept of ADC- flash type-DAC-Weighted network	3 1
	Module 5: Basic instrumentation and Digital electronics	**6**
5.1	Electronic instrumentation: Transducers: Basic principles of Strain guage, LVDT, Thermistor, Photodiode, microphones, Loud speaker.	2

5.2	Measurements: Multimeter and X-Y recorder.	1
5.3	Digital electronics: number systems - binary, octal and hexadecimal - conversion – representation of negative numbers using 1's compliment and 2's compliment method. Logic gates – truth table.	3
	Total Hours	**36 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Explain the significance of color coding in identifying the values of resistors.
2. What are the different types of capacitors and Give any two applications of capacitors?
3. Find the capacitance values for the following codes 1) 2n2 2) 104K

Course Outcome 2 (CO 2):

1. Describe the structure of a PN junction diode and its principle of operation
2. What is a regulated power supply? With neat block diagram Summarize the working of DC power supply
3. Narrate the working of capacitor filter.

Course Outcome 3 (CO 3):

1. Compare and contrast the structures of NPN and PNP bipolar junction transistors.
2. What is the need of voltage divider biasing in an RC coupled amplifier?
3. Analyze the importance of selection of operating point in the context of a BJT amplifier.

Course Outcome 4 (CO 4):

1. Describe the key differences between an inverting amplifier and a non-inverting amplifier using operational amplifiers.
2. Compare and contrast active and passive filters, providing examples of each.
3. Discuss the principle of operation of a Digital-to-Analog Converter (DAC) using a weighted network.

Course Outcome 5 (CO 5):

1. Convert 255.5210 to binary and hexadecimal.
2. Implement an AND gate using NOR gate
3. Define logic gates and explain their fundamental role in digital electronics

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24ES1T08

Course Name: FUNDAMENTALS OF ELECTRONICS ENGINEERING

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Identify the color code for the given resistor values
   (a) 1Ω + 5
   (b) 3.3kΩ + 1
   (c) 1 M Ω+ 5
2. Identify the capacitor value with unit.
   (a) 333
   (b) Brown, Black, Red, Brown, Brown
   (c) 103
3. The reverse saturation current of Germanium diode at room temperature is 0.4 micro ampere. Determine the current flowing through the diode when 0.2V is applied at room temperature.
4. Draw the circuit diagram of a full wave bridge rectifier
5. How to calculate the bandwidth of an RC coupled Amplifier?
6. Illustrate the structure of Enhancement MOSFET.
7. Draw the circuit of an inverting amplifier for a gain of 10.
8. Explain the working of an RC high pass filter.

9. Which gates are called universal gates and why?
10. Explain the principle of operation of photo diode

PART B

Answer any one question from each module. Each question carries 14 marks.

11. Explain the specifications of resistors, capacitors and Inductors

OR

12. With a neat diagram explain the working of electromechanical relay.
13. Explain Half wave rectifier with capacitor filter and draw the output waveforms with high value capacitor and low value capacitors

OR

14. Explain the working of Zener voltage regulator with the help of a neat circuit diagram? What is load regulation and line regulation
15. (a) Discuss in detail the working of a NPN transistor (7)
    (b) Explain the output characteristics of a common emitter configuration (7)

OR

16. Draw the circuit diagram of a typical RC Coupled amplifier with voltage divider bias. Explain the functions of each component.
17. What is the purpose of an Analog-to-Digital Converter (ADC)? Describe and illustrate how a Flash type ADC works.

OR

18. Explain a Digital-to-Analog Converter (DAC). How a DAC using a weighted network operates?
19. Explain the basic principle of LVDT with neat diagram. Give any one application of LVDT.

OR

20. Describe the working of
    (a) Multimeter (7)
    (b) X-Y Recorder (7)

B24ME1T02	STATICS AND DYNAMICS FOR ENGINEERS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course aims to impart the students with a solid comprehension of the fundamental concepts of mechanics. By bridging theory and application, students learn to tackle real-world challenges using reasoned assumptions. Emphasizing problem-solving, the course cultivates and sharpens students' analytical skills. Through theoretical instruction and practical exercises, students gain the ability to analyze and solve engineering problems effectively. Ultimately, the course aims to empower students with the knowledge and skills essential for addressing complex engineering dynamics and statics scenarios with confidence and proficiency.

Prerequisites

NIL

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Understand the rigid body mechanics theorems and principles. (Cognitive Knowledge Level: Apply)
CO 2	To apply the conditions of equilibrium to various practical problems involving different force systems. (Cognitive Knowledge Level: Apply)
CO 3	Determine the centroid and moment of inertia of various surfaces and solids. (Cognitive Knowledge Level: Apply)
CO 4	To apply principles of kinematics to bodies in motion. (Cognitive Knowledge Level: Apply)
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and Masses. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2									1
CO 2	1	3	3									1
CO 3	3	1	2									1
CO 4	3	2	2									1
CO 5	1	3	3	1								1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (% Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	20
Understand	30	30	40
Apply	60	60	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (8 hours)

Laws of mechanics- System of forces, System of concurrent forces, Resultant of a force system, Free body diagrams , Principle of transmissibility, Conditions of equilibrium - System of non-concurrent forces, Moment of a force, Varignon's Theorem, Couple, Resultant of non-concurrent forces- Equilibrium of system of forces, Conditions of equilibrium.

MODULE 2 (10 hours)

Analysis of Trusses, Method of joints, Method of sections, Support reactions of beams- Friction, Coulomb's law, Coefficient of friction, Angle of friction, Impending motion of connected bodies- Applications of friction, Screw friction, Belt friction.

MODULE 3 (8 hours)

Centre of Gravity and Centroid- Centroid, Centre of mass, Centre of Gravity, Relationship Between Centre of Gravity, Centre of Mass and Centroid- Moment of inertia, Second moment of area, Radius of gyration- Mass moment of inertia, Parallel axis theorem

MODULE 4 (9 hours)

Kinematics of Rectilinear motion, Displacement, velocity and acceleration, rectilinear motion- Kinematics of Curvilinear motion, Tangential and Normal Components of Acceleration, Radial and Transverse Components of Acceleration.

MODULE 5 (10 hours)

Kinetics of particles, Motion of Bodies in Rectangular Coordinates, Motion of Connected Bodies, D'Alembert's Principle. Planar Kinematics and Kinetics of rigid bodies-Rotation, Absolute motion, Relative motion, Instantaneous Center of Zero Velocity, Relative Acceleration, Motion relative to rotating axes, Work-energy relations, Impulse and momentum, Impulse-momentum principle. Basics of three-dimensional dynamics of rigid bodies (only theory)

Text Books

1. J.L. Meriam, "Engineering Mechanics: Volume 1: Statics, Volume 2: Dynamics", Wiley.

Reference Books

1. Irving H Shames, "Engineering mechanics: Statics and Dynamics", Pearson Education.
2. Michael E. Plesha, Gary L. Gray, et al, "Engineering mechanics: Statics and Dynamic", McGraw Hill Education.
3. S Timoshenko, D H Young, et al, "Engineering mechanics", McGraw Hill Education.
4. Russell Hibbeler, "Engineering mechanics: Statics and Dynamics", Pearson Education.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Module 1:	**8**
1.1	Laws of mechanics-system of forces.	1
1.2	System of concurrent forces: Resultant of a force system, Free body diagrams, Conditions of equilibrium, Principle of transmissibility.	2
1.3	System of non-concurrent forces: Moment of a force.	2
1.4	Varignon's Theorem, Couple.	1
1.5	Resultant of non-concurrent forces, Equilibrium conditions of system of forces.	2
	Module 2:	**10**
2.1	Analysis of Trusses: Method of joints	2
2.2	Method of sections	2
2.3	Support reactions of beams	2
2.4	Friction: Coulomb's law, Coefficient of friction,	1
2.5	Angle of friction, Impending motion of connected bodies.	1
2.6	Applications of friction: Screw friction, Belt friction.	2
	Module 3:	**8**
3.1	Centre of Gravity and Centroid: Centroid, Centre of mass, Centre of Gravity.	2
3.2	Relationship Between Centre of Gravity, Centre of Mass and Centroid.	1
3.3	Moment of inertia: Second moment of area.	2

3.4	Radius of gyration.	1
3.5	Mass moment of inertia, Parallel axis theorem	2
	Module 4	**9**
4.1	Kinematics of Rectilinear motion: Displacement, velocity and acceleration	1
4.2	Rectilinear motion Problems	2
4.3	Kinematics of Curvilinear motion: Tangential and Normal Components of Acceleration	2
4.4	Radial and Transverse Components of Acceleration.	2
4.5	Curvilinear motion problems	2
	Module 5:	**10**
5.1	Kinetics of particles: Motion of Bodies in Rectangular Co-ordinates.	2
5.2	Motion of Connected Bodies, D'Alembert's Principle.	2
5.3	Planar Kinematics and Kinetics of rigid bodies-Rotation, Absolute motion, Relative motion.	1
5.4	Instantaneous Center of Zero Velocity, Relative Acceleration, Motion relative to rotating axes.	2
5.5	Work-energy relations, Impulse and momentum, Impulse-momentum principle.	2
5.6	Basics of three dimensional dynamics of rigid bodies (only theory).	1
	Total Hours	**45 Hours**

CO ASSESSMENT QUESTIONS

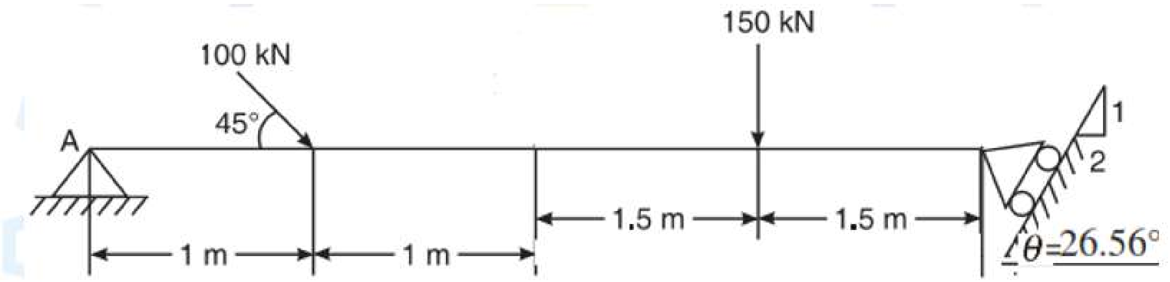
Course Outcome 1 (CO 1):

1. State and explain Lami's theorem
2. What are the conditions of equilibrium in concurrent and non-concurrent force system?
3. State and explain Varignon's theorem for concurrent coplanar forces.

Course Outcome 2 (CO 2):

1. A small block of weight 1000 N as shown in Figure, is placed on a 30° inclined plane with $= 0.25$. Determine the horizontal force to be applied for impending motion down the plane.

2. For the beam with loading shown in Fig, determine the reactions at the supports.

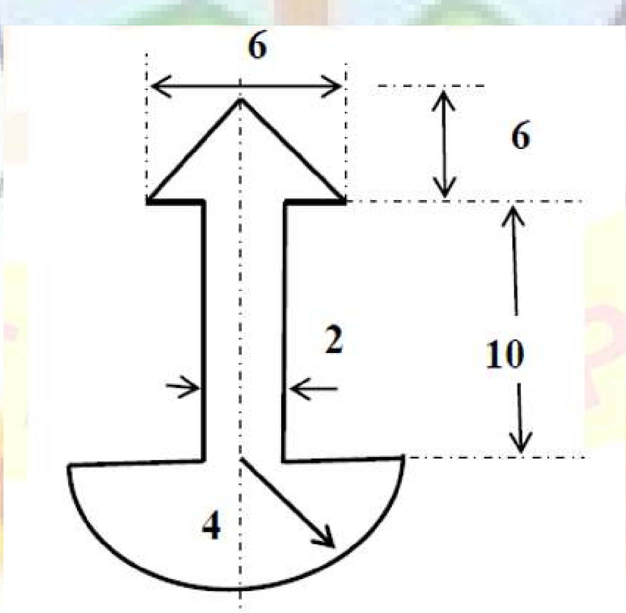


3. A simply supported beam AB of span 4m is carrying point loads 10N, 6N & 4N at 1m, 2m & 3m respectively from support A. Calculate reactions at supports A and B.

Course Outcome 3 (CO 3):

1. Calculate the area moment of inertia of a rectangular cross-section of breadth 'b' and depth 'd' about the centroidal horizontal axis

2. Find the moment of inertia of shaded area about the horizontal and vertical centroidal axis. All dimensions in cm.



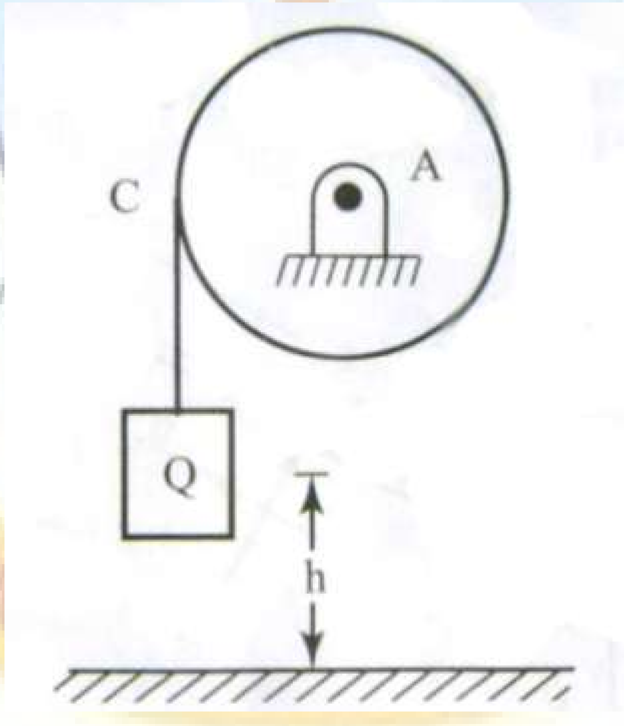
3. Write the formula for moment of inertia of a semi-circle about the centroidal axis parallel to the base and hence derive the formula for MI about an axis through its base.

Course Outcome 4 (CO 4):

1. The position of a particle moving along a straight line is defined by the relation . Determine the time taken by the particle when its velocity becomes zero.
2. A block of mass M1 resting on an inclined plane is connected by a string and pulleys to another block of mass M2 as shown in Fig. Find the tension in the string and acceleration of the blocks. Assume the coefficient of friction between the blocks M1 and the plane to be 0.2. M1 =1500N, M2 = 1000N. Angle of inclined plane = 45^o.
3. A 50 kg mass has a velocity of 10m/s horizontally on a smooth surface. Determine the magnitude of horizontal force required to bring the mass to rest in 5 seconds.

Course Outcome 5 (CO 5):

1. A flywheel weighing 500N and having radius of gyration 0.4 m loses it speed from 300rpm to 180 rpm in 1 minute. Calculate the torque acting on it.
2. A circular disc of radius r=30cm and weight W=145N is free to rotate about its geometric axis. A flexible cord carrying a weight of Q= 45N, is wound around the circumference of the disc as shown in Fig. If the weight Q is released from rest, find (a) the time t required for it to fall through the height h=300cm (b) with what velocity v will it strike the floor?



3. Explain instantaneous centre of zero velocity

MODEL QUESTION PAPER

QP CODE: **Pages: 4**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24ME1T02

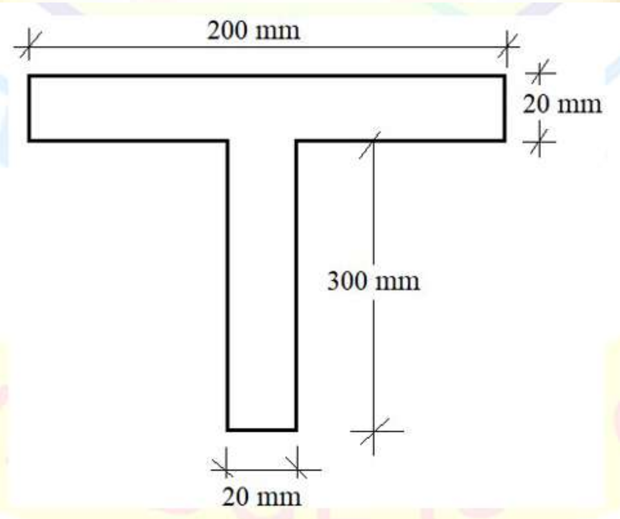
Course Name: STATICS AND DYNAMICS FOR ENGINEERS

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Define a couple and explain its characteristics.
2. The resultant of two forces, one of which is double the other, is 490 N. If the direction of the larger force is reversed and the other remains unaltered, the resultant reduces to 100N. Determine the magnitude of the forces and the angle between them.
3. A simply supported beam AB of span 5 m is carrying point loads 5 kN, 3 kN and 2 kN at 1m, 3m and 4m respectively from support A. Calculate the support reaction at B.
4. Distinguish static friction from dynamic friction
5. State and explain parallel axis theorem.
6. Find the centroid of the T section shown



7. The angular acceleration of a particle $= 5t\ rad/s^2$. Determine expression for angular velocity w at any instant 't' of the motion, if the particle starts from rest.

8. State D'Alembert's principle

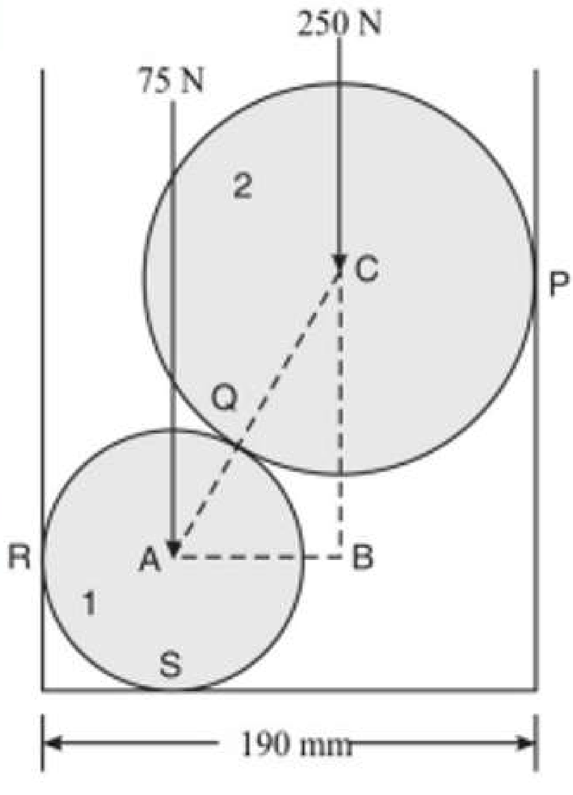
9. While you are riding your bike, you turn a corner following a circular arc. Illustrate the forces that act on your bike to keep you along the circular path

10. Illustrate the significance of instantaneous centre in the analysis of rigid body undergoing rotational motion.

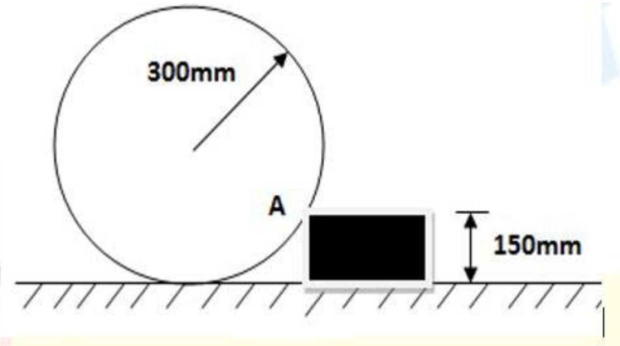
PART B

Answer any one question from each module. Each question carries 14 marks.

11. Determine the reactions at contact points P, Q, R, and S for the system shown in Figure. The radii of spheres 1 and 2 are, respectively, 40 mm and 60 mm (14 marks)

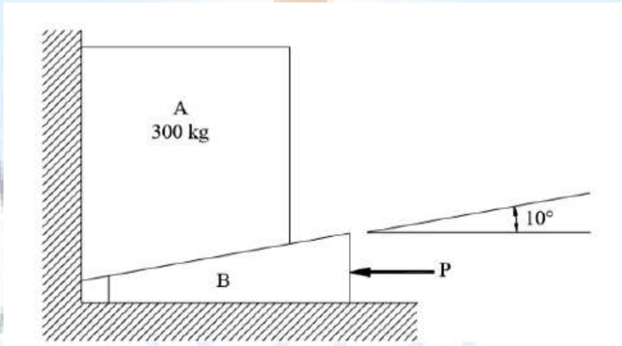


12. A roller of radius 300 mm and weight 1000N is to be pulled over a rectangular block of height 150mm as shown in fig. Determine (i) the horizontal force required to be applied through the centre and (ii) the required horizontal force when it is applied through the top end of vertical diameter. (14 marks)



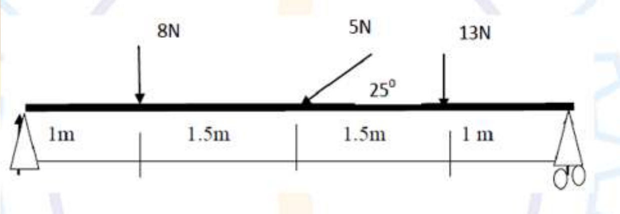
Module 2

13. If the coefficient of static friction equals 0.3 for all surfaces of contact, determine the smallest value of force P necessary to raise the block A of mass 300kg. Neglect the weight of the wedge B. Angle of wedge is 10°. (14 marks)



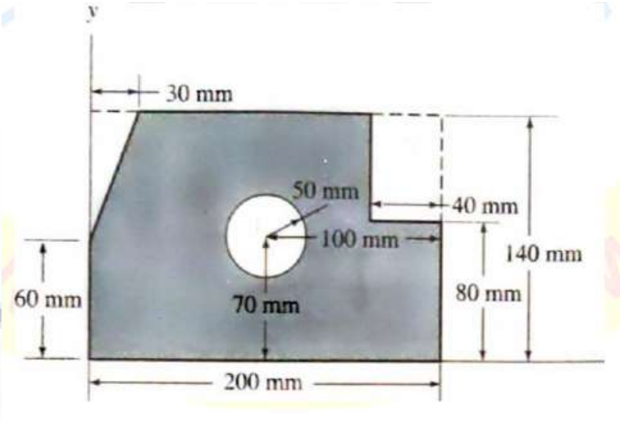
14. (a) What do you understand by the reactions at supports? (4 marks)

    (b) Find the reactions at the supports of the beam given. A is a hinged support and B is a roller support. (10 marks)

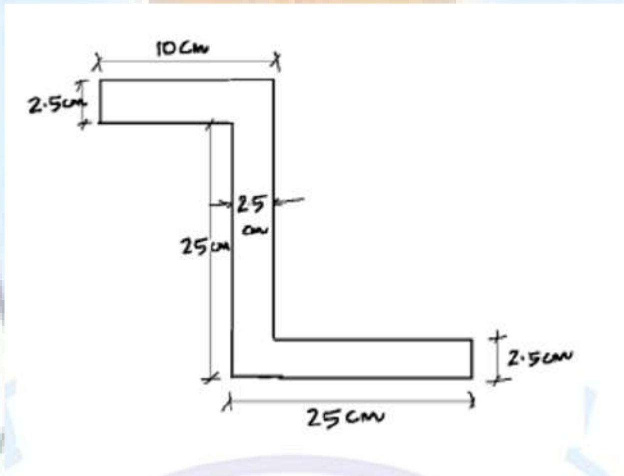


Module – 3

15. Find the centroid of the shaded area shown. (14 marks)

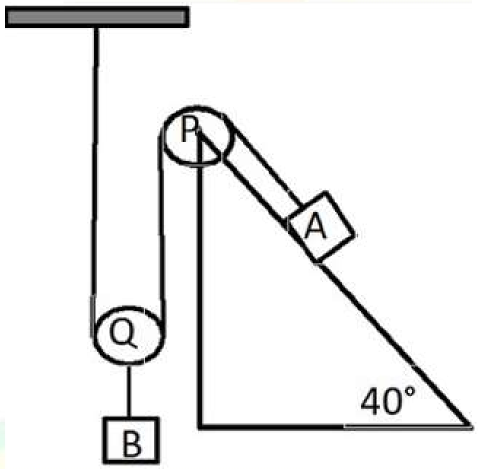


16. Find the centroid of the cross-sectional area of a Z section shown in figure. (14)



Module – 4

17. Determine the tension in the inextensible string and the acceleration of the masses. Consider the pulley as massless and coefficient of friction as 0.20. Block A=200 kg and block B=100kg (14 marks)



18. Two cars A and B travelling in same direction get stopped at a traffic signal. When signal turns green, car A accelerates at 0.75 m/s^2 and 1.75 seconds later, car B starts and accelerates at 1.1 m/s^2. Determine i) when and where B will overtake A and ii) the speed of each car at that time. (14 marks)

Module 5

19. (a) A flywheel rotates with a constant retardation due to breaking, in the first 10 seconds, it made 300 revolutions. At t = 7.5 sec, its angular velocity was 40 rad/s. Determine
    i. The value of constant retardation
    ii. The total time taken to come to rest and
    iii. The total revolutions made till it comes to rest (7marks)

    (b) Two blocks of masses 10 kg and 25 kg are attached to the two ends of a flexible rope. The rope passes over a pulley of diameter 500mm. The mass of the pulley is 7.5 kg and its radius of gyration is 200 mm. Find the acceleration of the masses and the tension on either side of the rope. (7marks)

20. A flywheel is made of steel ring 30mm thick 300 mm wide plate with mean diameter of 1.5m. If initially the flywheel is rotating at 250 rpm, find the time taken by the wheel in coming to rest due to frictional couple of 150 Nm. Take mass density of steel as 7900 kg/m^3. Neglect the effect of spokes. (14 marks)

B24ES1L05	ELECTRICAL AND ELECTRONICS WORKSHOP	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	2	2	1	2024

Preamble

This course is designed to equip students with the foundational knowledge and practical skills necessary to navigate the intricate world of electrical and electronics engineering. It aims to impart the fundamentals of electrical wiring, safety measures, and troubleshooting to students, and exposes them to the concepts of DC and AC electrical machines, allowing them to analyze their performances. The course also provides a basic introduction to electronic hardware systems and offers hands-on training in familiarization, identification, testing, assembling, dismantling, fabrication, and repairing such systems using various tools and instruments available in the electronics workshop.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Identify electrical symbols, measuring instruments, accessories, and tools used for electrical wiring. (Cognitive Knowledge Level: Apply)
CO 2	Understand the distribution system and safety measures against electrical shocks and select the fuse unit for a given electrical circuit. (Cognitive Knowledge Level – Understand)
CO 3	Analyze the performance of AC and DC machines. (Cognitive Knowledge Level – Analyze)
CO 4	Demonstrate proficiency in identifying various electronic components, including active, passive, electrical, electronic, and electromechanical components. (Cognitive Knowledge Level-Understand)
CO 5	Develop and illustrate electronic circuit diagrams using recognized standards such as BIS/IEEE symbols and utilize Electronic Design Automation (EDA) tools for schematic capture and simulation. (Cognitive Knowledge Level-Apply)
CO 6	Design and fabricate electronic circuits on boards, trouble shooting of minor problems in electronic equipment and handling of test and measuring equipment. (Cognitive Knowledge Level-Apply)

Mapping of Course Outcomes With Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	3	1		3	1	1	3	3	3	3
CO 2	3	2	3	1		3	1	1	3	3	2	3
CO 3	3	3	3	2		3	1	1	3	3	2	3
CO 4	3	1	1	1					1	1		2
CO 5	3	2	2	1	2				2	1		2
CO 6	3	2	2	1	2				2	1		1

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	70	30	1 hour

Continuous Internal Evaluation Pattern

Attendance	20 marks
Class Work/ Assessment /Viva-Voce	50 marks
End semester examination (Internally by college)	30 marks

End Semester Examination Pattern

The college will internally conduct the end semester examination. Separate ESE's will be held for the Electrical workshop and the Electronics workshop, each in the form of a one-hour written / objective exam. The total marks for this course will be equally divided between the Electrical and Electronics workshops.

SYLLABUS

LIST OF EXPERIMENTS
PART I

ELECTRICAL

1	(a) Familiarization with electrical symbols, measuring instruments, lighting and wiring accessories, tools, and various wiring systems. (b) To familiarize earthing in electrical installations, precautions against electric shock phenomenon and safety procedures.
2	Realization of domestic wiring (a) Wiring of one lamp controlled by two switches (Staircase wiring). (b) Wiring of three lamps controlled by three switches (Godown wiring).
3	(a) Study of fuse, MCB, ELCB, RCCB and selection of fuse rating for circuits with medium and high power. (b) Wiring of the distribution board, including the power plug, an isolator, MCB, and ELCB for 1000 W power.
4	Load test on DC shunt motor and to plot the performance characteristics.
5	(a) Load test on single-phase induction motor and to plot performance characteristics. (b) Load test on single-phase transformer and to plot performance characteristics.
6	Load test on a three-phase squirrel cage induction motor and to plot performance characteristics.
7	Regulation of a three-phase alternator by direct loading at full load upf.

Reference Books

1. D P Kothari & I J Nagrath, Basic Electrical Engineering, 4^{th} Edition, McGraw-Hill 2019.

2. EW. Golding, Electrical Measurements and Measuring Instruments, 5^{th} ed. Reem Publications, 2011.

3. Suresh Kumar K.S, Electrical Circuit and Networks, Pearson Education, New Delhi, 2009.
4. D P Kothari and I J Nagrath, Electric machines, 5^{th} edition ,2017.
5. V K Mehta, Basic Electrical Engineering, Revised edition, S. Chand & Company, New Delhi, 2012
6. J B Gupta, A course in electrical installation estimating and costing, 9^{th} edition, 2012
7. H Cotton, Advanced Electrical Technology, Reem Publications, 2011.
8. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.

PART II
ELECTRONICS

1	Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Relays, Crystals, Displays, Heat sink etc.) .
2	Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools (such as Dia ,XCircuit, LT SPICE).
3	Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, DSO etc.] [Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers etc.
4	Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using multimeter.
5	Inter-connection methods using Bread board and soldering practice. [Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general purpose PCB] .
6	Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.

7	Assembling of electronic circuit/system on general purpose PCB or breadboard, test and show the functioning (Any Two circuits). (a) Fixed voltage power supply with transformer, rectifier diode, capacitor filter, Zener/IC regulator. (b) Astable Multivibrator using Transistor (c) Sine wave generation using IC 741 OP-AMP in IC base. (d) RC coupled amplifier with transistor BC107. .

Reference Books

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, 2015.
2. Charles K. Alexander, Matthew N.O. Sadiku, Fundamentals of Electric Circuits, McGraw Hill Education Limited, 2022
3. M.W. Schwartz, The Soldering Handbook
4. Thomas L. Floyd, Electronic Devices Conventional current version, Pearson Education, 2015.

B24ME1L01	COMPUTER AIDED MACHINE DRAWING	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	3	2024

Preamble

The course in Computer-Aided Machine Drawing aims to familiarize students with industrial drafting practices and instill a comprehensive understanding of production drawings, preparing them for the demands of industry. Additionally, the course introduces Computer-Aided Drafting techniques and 2D Modeling to enhance students' proficiency in modern design methodologies. Through practical application and theoretical instruction, students will develop the skills necessary to produce industry-standard production drawings and navigate the complexities of machine drawing in a digital environment. By the conclusion of the course, students will be equipped with the knowledge and practical experience to excel in the field of computer-aided machine drawing and contribute effectively to the industry.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply the knowledge of engineering drawings and standards to prepare standard dimensioned drawings of machine parts and other engineering components. (Cognitive Knowledge Level: Apply)
CO 2	Apply limits and tolerances to components and choose appropriate fits for given assemblies, surface roughness required. (Cognitive Knowledge Level: Apply)
CO 3	Draw the machine elements detachable joints. (Cognitive Knowledge Level: Understand)
CO 4	Draw the machine elements permanent joints. (Cognitive Knowledge Level: Understand)
CO 5	Prepare part and assembly drawings and Bill of Materials of machine components and valves using CAD software. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1						1		3		2
CO 2	3	3		3				1		3		2
CO 3	3	2	3		3				1	3		2
CO 4	3	2	3		3				1	3		2
CO 5	3	3	3		3				1	3		2

Assessment Pattern

Bloom's Category	**Continuous Assessment**	**End Semester Examination (% Marks)**
	Test 1 (%Marks)	
Remember	10	10
Understand	40	30
Apply	50	60
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Classwork /Assesment viva voce	50 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

ESE will be of 2.5-hour duration and will be for 75 marks. The question paper contains two parts. In part A, the first question is compulsory and will be based on modules 1 & 2, carrying 10 marks. The second and third questions will carry 15 marks (the student need to answer only one of these) and will be from module 3 and 4 respectively. Part A should be answered in the A4 size answer booklet provided.

Part B Consists of one question from module 5 (compulsory) which carries 50 Marks. The drafting/drawing of the Part B question should be made in a suitable CAD software.

SYLLABUS

Module 1 (3 hours)
Principles of drawing:
Importance of machine Drawing. BIS code of practice for Engineering Drawing, Lines, types of lines, dimensioning, scales of drawing, sectional views.

Module 2 (6 hours)
Fits and Tolerances: Limits, fits, and tolerances of size and form; Types and grade, use of tolerance tables and specification of tolerances, form and cumulative tolerances, tolerance dimensioning, general tolerances.
Surface Roughness: Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc. Surface quality symbols, terminology and representation on drawings.

Module 3 (6 hours)
Detachable Fasteners:
Screw threads, approximate and conventional representations; Specifications.
Threaded fasteners: Types, forms, standard, and specifications;
Drawing of temporary connections;
Foundation bolts; Locking Devices: Classification, principles of operation, standard types and their proportions.

Module 4 (6 hours)
Permanent Fastenings:
Rivets: Standard forms and proportions; Riveted Joints: Common types of joints, terminology, proportions and representation.
Welds: Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings.

Module 5 (15 hours)
Introduction to drafting software Auto CAD: Basic commands, keyboard shortcuts. Coordinate and unit setting, Drawing, Editing, Measuring, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.
Assembly drawings (2D) with Bill of materials: Drawing of Shaft couplings and Oldhams couplings , Lathe Tailstock and Universal joint , Connecting rod and Plummer block , Rams Bottom Safety Valve, steam stop valve.

Reference Books

1. N. D. Bhatt, *Machine Drawing*, Charotar Publishing House Pvt Ltd, 2016.
2. N. Sidheswar, P. Kanniah and V.V.S. Sastry, *Machine Drawing*, Tata McGraw Hill, 2001
3. SP 46: 1988 *Engineering Drawing Practice for School & Colleges.* Bureau of Indian Standards
4. K. R. Gopalakrishna, *Machine Drawing*, 9th Ed., Subhas Stores, Bangalore, 2005.
5. P I Varghese and K C John, *Machine Drawing*, VIP Publishers.

COURSE CONTENTS AND LAB SCHEDULE

No	**Topic**	**No of Lecture/Tutorial Hours**
	Module 1	**3**
1.1	Importance of machine Drawing	1
1.2	BIS code of practice for Engineering Drawing, Lines, types of lines, dimensioning	1
1.3	Scales of drawing, sectional views	1
	Module 2	**6**
2.1	Limits, fits, and tolerances of size and form	1
2.2	Types and grade, use of tolerance tables and specification of tolerances, form and cumulative tolerances	2
2.3	Tolerance dimensioning, general tolerances	1
2.4	Preparation of production drawings and reading of part and assembly drawings	1
2.5	Surface roughness, indication of surface roughness, etc. Surface quality symbols, terminology and representation on drawings	1
	Module 3	**6**
3.1	Screw threads, approximate and conventional representations; Specifications, Threaded fasteners: Types, forms, standard, and specifications	3
3.2	Drawing of temporary connections, Foundation bolts; Locking Devices: Classification, principles of operation, standard types and their proportions	3
	Module 4	**6**
4.1	Rivets: Standard forms and proportions, Riveted Joints: Common types of joints, terminology, proportions and representation	3

4.2	Welds: Types of welds and welded joints, Edge preparation, specifications, and representation of welds on drawings	3
	Module 5	**15**
5.1	Introduction to drafting software Auto CAD, basic commands, keyboard shortcuts. Coordinate and unit setting, Drawing, Editing, Measuring, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	3
5.2	Assembly drawings (2D) with Bill of materials: Drawing of Shaft couplings and OldhamS coupling	3
5.3	MAssembly drawings (2D) with Bill of materials: Lathe Tailstock, Universal joint	3
5.4	Assembly drawings (2D) with Bill of materials: Connecting rod , Plummer block	3
5.5	Assembly drawings (2D) with Bill of materials: Rams Bottom Safety Valve, steam stop valve	3
	Total Hours	**36 Hours**

MODEL QUESTION PAPER

QP CODE: **Pages: 3**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24ME1L01

Course Name: COMPUTER AIDED MACHINE DRAWING

Max. Marks: 75 Duration: 2.5 hours

All dimensions in mm. If required, assume missing data appropriately

PART A (SKETCHING) – 25 Marks

(To be answered in A4 sheet)

Question No. 1 is compulsory. From questions 2 and 3 you may answer any one question.

1. Explain surface texture nomenclature with a neat sketch (10 marks)
2. Draw three views of a hexagonal nut having size M30. (15 marks)

or

3. Draw a top half sectional elevation of a Socket and spigot joint which is suitable for shaft having diameter 24 mm. (15 marks)

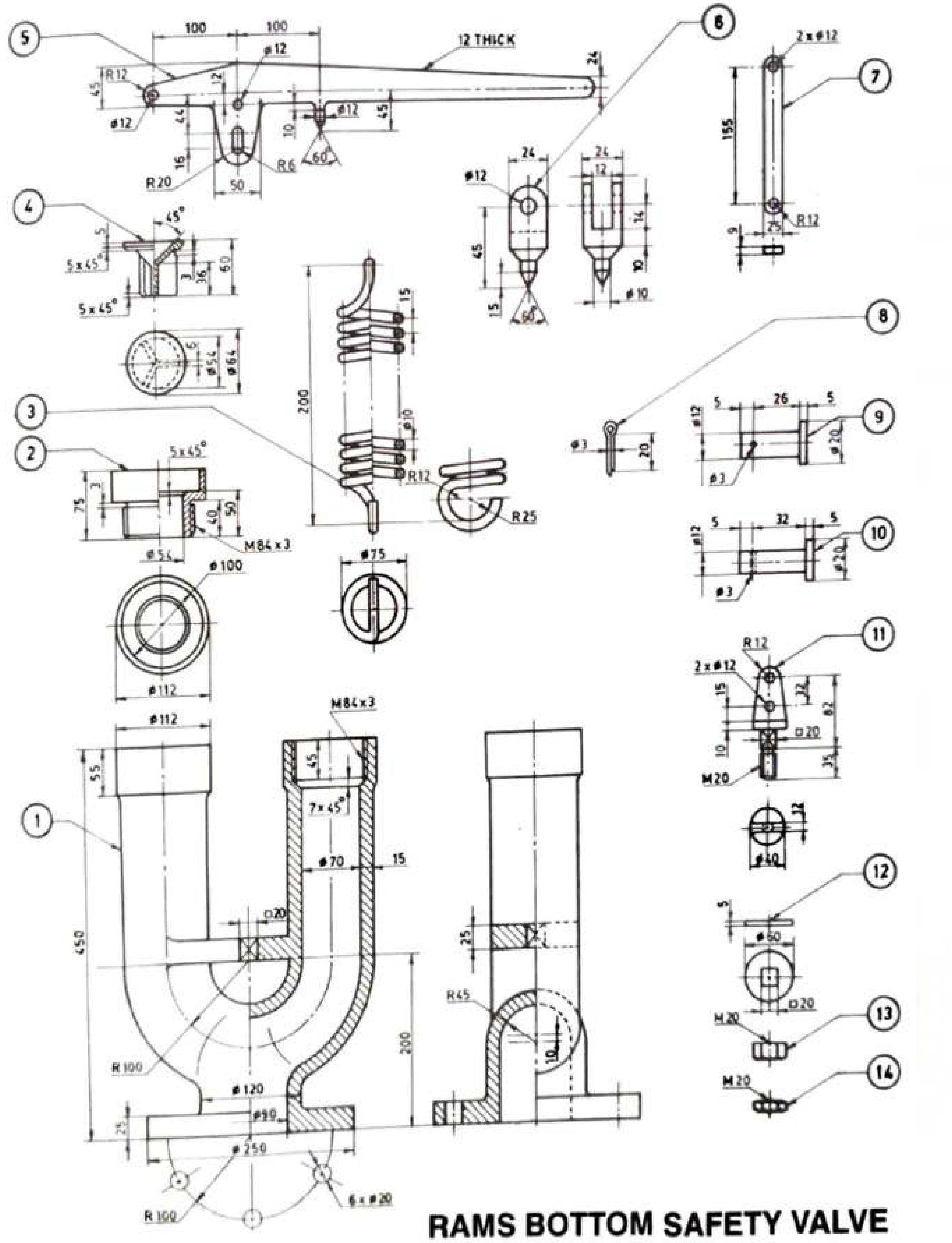
PART B (CAD DRAWING) - 50 Marks

To be drawn/ drafted using any CAD software

4. Draw the assembled view of Rams bottom safety valve as per the given data using any suitable CAD software.

ITEM LIST

Item	Description	Qty.	Material
1	Body	1	C.I.
2	Valve seat	2	G.M.
3	Spring	1	Steel
4	Valve	2	G.M.
5	Lever	1	M.S.
6	Pivot	1	M.S.
7	Link	2	M.S.
8	Split pin	3	M.S.
9	Pin for link	2	M.S.
10	Pin for pivot	1	M.S.
11	Shackle	1	M.S.
12	Washer	1	M.S.
13	Nut	1	M.S.
14	Lock nut	1	M.S.



RAMS BOTTOM SAFETY VALVE

B24PH1L01B & B24CY1L01A	**ENGINEERING PHYSICS LAB (B) & ENGINEERING CHEMISTRY LAB (A)**	**L**	**T**	**P**	**S**	**CREDIT**	**YEAR OF INTRODUCTION**
		0	0	2	2	1	2024

PART I
ENGINEERING PHYSICS LAB (B)

Preamble

This course is designed to complement and enhance the students' understanding of fundamental principles in physics through hands-on experimentation and practical application. The primary aim of this laboratory course is to provide students with an experience that bridges the gap between theoretical concepts and real-world challenges. By actively engaging in experiments, students will develop crucial skills in observation, measurement, analysis, problem-solving and team work. These skills are essential in preparing students to tackle complex engineering problems in their future career.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Develop analytical / experimental skills and impart prerequisite hands-on experience for engineering laboratories. (Cognitive Knowledge Level: Apply)
CO 2	Understand the need for precise measurement practices for data recording. (Cognitive Knowledge Level: Apply)
CO 3	Understand the principle, concept, working and applications of relevant technologies and compare results with theoretical calculations. (Cognitive Knowledge Level: Apply)
CO 4	Develop technical skills associated with the usage of modern scientific tools. (Cognitive Knowledge Level: Apply)
CO 5	Develop basic communication skills through working in groups in performing the laboratory experiments and interpreting the results. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1			1	1			1	2		1
CO 2	3	1			1				1	2	1	1
CO 3	3	1			1				1	2	1	1
CO 4	3	1			2				1	3		1
CO 5	3	1			1	1		3	3			1

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
50	35	15	30 minutes

Continuous Internal Evaluation Pattern

Attendance	10 marks
Class Work/ Assessment Viva-Voce	25 marks
End semester examination (Internally by the college)/ Test	15 marks

End Semester Examination Pattern

The college will internally conduct an end semester examination in the form of a 30 minutes written objective examination.

SYLLABUS

LIST OF EXPERIMENTS

1	DSO - Measurement of Frequency and Amplitude.
2	LCR Circuit – Calculation of Q Factor.
3	Measurement of strain using strain gauge and wheatstone bridge.
4	Ultrasonic Diffractometer - measurement of wavelength.

5	Optic Fiber - Measurement of Numerical Aperture.
6	Melde's String - Measurement of Linear Density.
7	Deflection magnetometer-Moment of a magnet- tan A position.
8	Optic Fiber - Measurement of Bending Loss.

Reference Books

1. S.L. Gupta and Dr. V. Kumar, "Practical Physics with viva voice", Pragati Prakashan Publishers, Revised Edition, 2009.

2. M.N. Avadhanulu, A.A. Dani and Pokely P.M, "Experiments in Engineering Physics", S.Chand & Co, 2008.

3. S. K. Gupta, "Engineering physics practicals", Krishna Prakashan Pvt. Ltd., 2014 .

4. P. R. Sasikumar, "Practical Physics", PHI Ltd., 2011.

5. D.R Mehta, "Laboratory Manual Physics", D.K Publishing House.

PART II
ENGINEERING CHEMISTRY LAB (A)

Preamble

The aim of this course is to develop a scientific a pproach a nd t o b ridge t he g ap between theoretical chemistry and the applications of chemistry in the field o f e ngineering. This course is designed to familiarize the students with experimental skills through hands-on training, and the students will demonstrate an understanding of the practical applications of these skills while carrying out the research projects in their respective branch of engineering.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Understand and practice fundamental techniques in chemistry to generate experimental skills. (Cognitive Knowledge Level: Apply)
CO 2	Learn to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments. (Cognitive Knowledge Level: Apply)
CO 3	Acquire the ability to understand different methods of chemical synthesis and instrumental techniques to solve various engineering problems. (Cognitive Knowledge Level: Apply)
CO 4	Function as a team member, communicate effectively and engage in further learning while carrying out the experiment. (Cognitive Knowledge Level: Apply)
CO 5	Understand the importance of chemistry in the curriculum and how it addresses the social, economical and environmental problems. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2		1	1	1							2
CO 2	2	2	2	2	1							2
CO 3	2	2	2	1	2							2
CO 4	2								3	3	2	3
CO 5	2	1				2	3					3

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
50	35	15	30 minutes

Continuous Internal Evaluation Pattern

Attendance	10 marks
Class Work/ Assessment Viva-Voce	25 marks
End semester examination (Internally by the college)/ Test	15 marks

End Semester Examination Pattern

The college will internally conduct an end semester examination in the form of a 30 minutes written objective examination.

SYLLABUS

LIST OF EXPERIMENTS
(MINIMUM FOUR EXPERIMENTS ARE MANDATORY)

1	Determination of molar absorptivity of a compound.
2	Potentiometric redox titration.
3	Verification of Nernst equation using Daniel cell.
4	Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} ions in the solution.
5	Electroplating with copper.
6	Synthesis of iron oxide nanoparticles.
7	Estimation of sodium ions by flame photometry.
8	Synthesis of conducting polyaniline from aniline.

Reference Books

1. G. Svehla, B. Sivasankar, "Vogel's Qualitative Inorganic Analysis", Pearson, 2012.
2. R. K. Mohapatra, "Engineering Chemistry with Laboratory Experiments", PHI Learning, 2017.
3. Muhammed Arif, "Engineering Chemistry Lab Manual", Owl publishers, 2019.
4. Roy K. Varghese, "Engineering Chemistry Laboratory Manual", Crown plus Publishers, 2019.
5. Soney C. George, Rino Laly Jose, "Lab Manual of Engineering Chemistry", S. Chand & Company Pvt Ltd., New Delhi, 2019.
6. S. M. Ashraf, "A Laboratory Manual of Polymers" I. K. International Publishing House Pvt. Ltd., 2008
7. Ulrich Schubert, Nicola Hüsing, "Material Synthesis: A Practical Guide", Springer Vienna, 2008.
8. Anu Tresa Sunny, Prajitha Velayudhan, Sabu Thomas, "Colloidal metal Oxide Nanoparticles: Synthesis, Characterization and Applications", Elsevier Science, 2019.

B24MC1T03	PROFESSIONAL COMMUNICATION AND ETHICS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	0	1	3	P/F	2024

Preamble

This course aims to provide the students with the vital skills needed to excel in listening, reading, writing, and speaking. Whether conveying technical ideas or non-technical information, mastering these communication elements is crucial for aspiring professionals. The goal is to equip students with the ability to comprehend and successfully articulate ideas while also honing their persuasive communication skills. The course also aims to create in students awareness on ethics and human values.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Expand vocabulary and linguistic proficiency pertinent to the field of engineering (Cognitive Knowledge Level: Apply)
CO 2	Examine, comprehend, and succinctly describe a range of textual material. (Cognitive Knowledge Level: Apply)
CO 3	Produce clear, technically sound documents and presentations that follow all required conventions. (Cognitive Knowledge Level: Apply)
CO 4	Manifest acute ethical awareness and effectively apply ethical principles in practical engineering scenarios. (Cognitive Knowledge Level: Apply)
CO 5	Analyze and address global ethical issues, showcasing an understanding of their roles as ethical leaders and contributors to technological development. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						2	1	2	3	1	2	
CO 2						3	1	3	3	2	2	
CO 3						3	1	3	3	3	3	
CO 4	3	3	2	2	2	2	2	3	2	2	2	2
CO 5	2	2	2	2	2	2	2	3	2	2	2	3

Assessment Pattern

Bloom's Category	Continuous Assessment	End Semester Examination (% Marks)
	Test (% Marks)	
Remember	30	30
Understand	40	40
Apply	30	30
Analyse		
Evaluate		
Create		

Mark Distribution

Total Marks	CIE Marks	ESE Marks
100	50	50

Continuous Internal Evaluation Pattern

Attendance	10 marks
Regular assessment	15 marks
Series test (one test, conducted for 50 marks and reduced to 25)	25 marks

Regular assessment

Project report presentation and technical presentation through PPT	4 marks
Listening Test	2 marks
Group discussion/mock job interview	4 marks
Resume submission	2 marks
Assignment/Case study	3 marks

End Semester Examination Pattern

Total Marks: 50, Time: 2 hours. There will be two parts; Part A and Part B. Part A contain 4 questions carrying 5 marks each. Part B contains one question from each module in two sets of which students should answer one from each set. Each question can have a maximum of 2 sub-divisions and carry 15 marks each.

SYLLABUS

MODULE 1 (9 hours)

Communication Process

Modes, Verbal and Non-Verbal Communication, Verbal Aptitude- Misspelled Words, synonyms, paraphrasing, sentence completion using appropriate words, subject-verb agreement, Reading-Strategies for Effective Reading, types, Listening-Active and Passive Listening, Barriers, Taking notes while listening Activity- Worksheets, Exercises, Synthesizing and deriving conclusions from technical articles videos, and podcasts

MODULE 2 (9 hours)

Professional discipline

Public Speaking- Technical Talks- Formal and Informal Letters- Emails- Resume Preparation, Video Profile- GD Vs Debate-Dynamics of Professional Presentation (Individual and Group)- Format of Report, Proposal and Minutes.
Activity- Public Speaking, Podcast preparation, Resume preparation, Video profile creation, Company profiling, Group discussion, Technical Proposal, Structured Flow Analysis using AI.

MODULE 3 (9 hours)

Fundamentals of Ethical Engineering

Introduction to Human Values - Morals, Ethics, and Integrity - Academic and Work Ethics - Service Learning and Civic Virtue - Respect, Peaceful Living, Caring, and Sharing - Values of Honesty, Courage, Cooperation, Commitment, Empathy, and Self-Confidence - Senses of Engineering Ethics - Moral Autonomy and Ethical Theories - Moral Issues and Dilemmas in Engineering.

MODULE 4 (9 hours)

Professional Responsibility in a Global Context

Engineering as Social Experimentation - Responsible Experimentation and Codes of Ethics - Customs, Religion, and their Role in Engineering Ethics - Collegiality, Loyalty, and Conflict Management - Confidentiality, Conflicts of Interest, and Occupational Crime - Rights and Responsibilities in Engineering - Global Ethical Issues: Multinational Corporations, Environmental Ethics, Business Ethics, and Computer Ethics - Engineers as Leaders, Expert Witnesses, and Contributors to Technological Development.

Text Books

1. Ashraf Rizvi, "Effective Technical Communication", 2^{nd} Edition, McGraw Hill Education, 2017.
2. Meenakshi Raman and Sangeetha Sharma, "Technical Communication: Principles and Practice", 2^{nd} Edition, Oxford University Press, 2011
3. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
4. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi,2006.

Reference Books

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
2. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6^{th} edition, 2015.
3. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4^{th} edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United states,2005.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
	Total Hours	36 Hours
	Module 1 (Communication Process)	9
1.1	Modes, Verbal and Non-Verbal Communication,	1
1.2	Verbal Aptitude- Misspelled Words, synonyms, paraphrasing,	1
1.3	Sentence completion using appropriate words, subject verb agreement,	1
1.4	Reading-Strategies for Effective Reading, types .	1

1.5	Listening-Active and Passive Listening, Barriers, Taking notes while listening.	1
1.6	Activity- Public Speaking, Podcast preparation, Resume preparation, Video profile creation, Company profiling, Group discussion, Technical Proposal.	4
	Module 2 (Professional discipline)	9
2.1	Public Speaking- Technical Talks- Formal and Informal Letters	1
2.2	Emails- Resume Preparation, Video Profile, GD Vs Debate	1
2.3	Dynamics of Professional Presentation (Individual and Group).	1
2.4	Format of Report, Proposal and Minutes.	1
2.3	Activity- Public Speaking, Podcast preparation, Resume preparation, Video profile creation, Company profiling, Group discussion, Technical Proposal.	5
	Module 3 (Fundamentals of Ethical Engineering)	9
3.1	Introduction to Human Values - Morals, Ethics, and Integrity	1
3.2	Academic and Work Ethics - Service Learning and Civic Virtue - Respect, Peaceful Living, Caring, and Sharing.	2
3.3	Values of Honesty, Courage, Cooperation, Commitment, Empathy, and Self-Confidence.	2
3.4	Senses of Engineering Ethics - Moral Autonomy and Ethical Theories.	2
3.5	Moral Issues and Dilemmas in Engineering.	2
	Module 4 (Professional Responsibility in a Global Context)	9
4.1	Engineering as Social Experimentation - Responsible Experimentation and Codes of Ethics.	1
4.2	HCustoms, Religion, and their Role in Engineering Ethics - Collegiality, Loyalty, and Conflict Management	2
4.3	Confidentiality, Conflicts of Interest, and Occupational Crime.	1
4.4	Rights and Responsibilities in Engineering - Global Ethical Issues.	1
4.5	Multinational Corporations, Environmental Ethics, Business Ethics, and Computer Ethics.	2
4.6	Multinational Corporations, Environmental Engineers as Leaders, Expert Witnesses, and Contributors to Technological Development.	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):

1. Analyze how different modes of communication impact the overall message.
2. Identify and use appropriate verbal communication skills in various contexts..
3. Identify different types of reading and apply suitable strategies accordingly
4. Recognize and overcome barriers to effective listening.

Course Outcome 2 (CO 2):

1. Demonstrate confidence and competence in public speaking.
2. Compose well-structured written communications.
3. Participate effectively in group discussions and debates, showcasing critical thinking and communication skills.

Course Outcome 3 (CO 3):

1. Understand the format and structure of professional reports and proposals.
2. Summarize and organize information effectively in meeting minutes.
3. Adapt presentation style based on the context and audience.

Course Outcome 4 (CO 4):

1. Explain the role of professional ethics in technological development
2. Explain the need for environmental ethics in engineering projects
3. How civic virtue and integrity contribute to application of ethical principles

Course Outcome 5 (CO 5):

1. Explain how ethical issues in the workplace affect the development of a company.
2. Show how occupational crimes are resolved by keeping the rights of employees
3. Explain the necessity of code of conduct for digital ethics

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24MC1T03

Course Name: PROFESSIONAL COMMUNICATION AND ETHICS

Max. Marks: 50 Duration:2 hours

PART A

Answer all questions. Each question carries 5 marks.

1. Find out which pair of words 'can be filled-up in the blanks in the sentence in the same sequence to make the sentence grammatically correct and meaningfully complete.
   (a) He was ...... not to ...... done the exercise himself.
   a) expected, be b) required, being c) needed, get d) supposed, have
   (b) A committee has been…………..to………….the transformation of the city into an international finance center.
   a) Constituted, convert b) appointed, oversee c) inducted, change d) converged, evaluate
2. Highlight the differences between a group discussion (GD) and a debate.
3. Briefly explain morals, values, and ethics.
4. Provide an explanation on conflicts of interest with an example.

PART B

Answer any one question from each set. Each question carries 15 marks.

5. (a) "In today's world, being a good listener is more important than being a good Speaker." Enumerate (7)

(b) Help your friend by suggesting and explaining methods to improve his/her reading skills.. (8)

OR

6. (a) Compare and contrast the formats of a proposal and a report (7)

   (b) Discuss the challenges and benefits of delivering a presentation in a group setting (8)

7. (a) Exemplify a comprehensive review of integrity and respect for others. (8)

   (b) Explain how caring and sharing differ or exhibit similarities. (7)

OR

8. (a) Explain in detail about professional rights and employee rights. (8)

   (b) Explain the necessity of code of conduct for digital ethics. (7)

B24MC1L02	IDEA LAB	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	P/F	2024

Preamble

This course enables the students to understand the concepts of design, development and documentation tools under various domains in engineering. The various topics covered in this course are concepts of 2D and 3D design, cutting, routing, engraving, milling, slicing, printing and fabrication. Students will be exposed to PCB design and populating. They will learn Microcontroller programming, embedded system design and technical documentation. This course helps students to analyse real-life problems and find solutions using multidisciplinary engineering.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Create 2D and 3D models using appropriate tools. (Cognitive Knowledge Level : Analyse)
CO 2	Design and fabricate circuits using PCB Design and fabrication mechanisms.(Cognitive Knowledge Level : Analyse)
CO 3	Develop project using appropriate Micro controller Programming.(Cognitive Knowledge Level : Apply)
CO 4	Build a product for some applications using design and fabrication technologies.(Cognitive Knowledge Level : Create)
CO 5	Create electronic documentation for the system/project using appropriate tools .(Cognitive Knowledge Level : Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	3		2				1	1		
CO 2	1		1		1						1	1
CO 3	2	2	2	2	2	1	1	1	2	2	2	2
CO 4	1	2	3	2	3	2	3	3	3	3	3	3
CO 5						1				3		

Mark Distribution

Total Marks	CIE Marks	ESE Marks (Internal) Micro Project
100	50	50

Continuous Internal Evaluation Pattern

Attendance 10 marks
Class Work/ Assessment 30 marks
Viva-Voce/ Test 10 marks

End Semester Evaluation Pattern:

Micro project Demonstration 20 marks
Micro Project Presentation 20 marks
Micro Project Report 10 marks

Note: The microproject has to be completed by the students as a group of a maximum of four students.

SYLLABUS

LIST OF EXPERIMENTS

Complete at least six experiments and one micro project from the given list.

1	Prepare a 2D and 3D model using any standard tool.
2	Use the 2D model to engrave and cut the acrylic sheet using laser cutter. Assemble the laser-cut parts to fabricate the final model.
3	Use the 2D model for the fabrication of a model by using CNC milling.
4	Use a 3D model to engrave the pattern using CNC milling on the acrylic/wood/plastic block.
5	Use the 3D design for the fabrication of a model by using a 3D printer. Use a slicing software and generate the corresponding G-codes.
6	Write a program to read the input port pins of a micro controller and write the same to the output pins. Use a development board.
7	Write a program to read a sensor (temperature) and display it.
8	Write a program in Arduino IDE for Arduino development board to design a temperature controller. Control the speed of a fan based on the room temperature. Display the temperature on an LCD display.

9	Design a system to display the data send from the embedded system on a GUI in another Embedded system or PC (Wired – UART, I2C, SPI. Wireless – Bluetooth, Wifi)
10	Complete a Microproject. Prepare a technical report using latex for the temperature controller system in the standard template of the university.

Reference Books

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing.
2. 3D Printing and Design, Dr. SabrieSoloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
3. The Big Book of Maker Skills: Tools and Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
4. The Total Inventors Manual (Popular Science): Transform Your Idea into a Top Selling Product. Sean Michael Ragan(Author).Weldon Owen;2017.ISBN-13:978-1681881584.
5. Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978- 352137374 .
6. The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269 .
7. Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542 .
8. Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 9789352133703.
9. Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586.
10. Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633 .
11. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13: 978-1260019193.
12. Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13: 9781484200773.
13. Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer.
14. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer,2010 .
15. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and Distributors, 5th Edition, 2002.

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 3

SYLLABUS

SEMESTER 3

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA2T03A	COMPLEX VARIABLES AND APPLICATIONS OF PDE	3-1-0-3	4	4
B	B24ME2T01	MECHANICS OF SOLIDS	3-1-0-3	4	4
C	B24ME2T02	MECHANICS OF FLUIDS	3-1-0-3	4	4
D	B24ME2T03	METALLURGY AND MATERIALS SCIENCE	2-1-0-2	3	3
E	B24HU2T02	ENTREPRENEURSHIP AND MANAGEMENT SKILLS FOR ENGINEERS	2-1-0-2	3	3
G	B24ME2L02	MATERIAL TESTING LAB	0-0-3-3	3	2
H	B24ME2L03	MACHINE TOOLS LAB	0-0-3-3	3	2
I	B24MC2T04	UNIVERSAL HUMAN VALUE AND CONSTITUTIONAL RIGHTS	2-0-0-2	2	P/F
J	B24MC2T05	ENERGY CONSERVATION AND ENVIRONMENTAL SUSTAINABILITY	2-0-0-2	2	P/F
M	B24MEM3x	MINOR	3-1-0-3	4	4
			TOTAL	**32**	**22**

MINOR COURSES

BASKET	COURSE NO.	COURSES
BASKET I (DESIGN)	B24MEM31	MECHANICS OF MATERIALS
BASKET II (THERMAL)	B24MEM32	FLUID MECHANICS & MACHINERY
BASKET III (PRODUCTION)	B24MEM33	MATERIAL SCIENCE & TECHNOLOGY

B24MA2T03A	COMPLEX VARIABLES AND APPLICATIONS OF PDE	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble:

This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. To understand the basic theory of functions a complex variable residue integration and conformal transformation**.**

Prerequisite:

A basic course in partial differentiation and complex numbers.

Course Outcomes:

After the completion of the course the student will be able to:

CO1	Solve Nonlinear and linear partial differential equations (Cognitive Knowledge Level: Apply)
CO2	Solve one dimensional wave equation and heat equation using partial differential equations (Cognitive Knowledge Level: Apply)
CO3	Make use of Cauchy-Riemann equations to understand complex functions, its continuity and differentiability (Cognitive Knowledge Level: Apply)
CO4	Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula (Cognitive Knowledge Level: Apply)
CO5	Develop power series expansion for an analytic function. (Cognitive Knowledge Level: Apply)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1		1							1
CO 2	3	2	1		1							1
CO 3	3	2	1		1							1
CO 4	3	2	1		1							1
CO 5	3	2	1		1							1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (% Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 has to be answered. Each question carries 14 mark and can have a maximum of 2 sub-divisions.

SYLLABUS

MODULE 1: Partial Differential Equations (9 hours)

(Text 1-Relevant portions of sections 17.1, 17.2, 17.3, 17.4, 17.5, 17.7, 18.1, 18.2)

Partial differential equations, Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, Solutions of a partial differential equations-Equations solvable by direct integration, Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order-Charpit's method, Solution of equation by method of separation of variables.

MODULE 2: Applications of Partial Differential Equations (9 hours)

(Text 1-Relevant portions of sections 18.3,18.4, 18.5)

One dimensional wave equation- vibrations of a stretched string, solution of the wave equation using method of separation of variables, D' Alembert's solution of the wave equation, One dimensional heat equation, solution of the heat equation.

MODULE 3: Complex Variable – Differentiation (9 hours)

(Text 2 -Relevant portions of sections 13.3,13.4,17.1,17.2)

Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equation harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2$, $w = e^z$, linear fractional transformation $w = \frac{1}{z}$, fixed points.

MODULE 4: Complex Variable – Integration (9 hours)

(Text 2- Relevant topics from sections14.1, 14.2, 14.3, 14.4)

Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method- indefinite integration and substitution of limit, second evaluation method-use of a representation of a path, Contour integrals, Cauchy integral theorem on simply connected domain, Cauchy Integral formula

MODULE 5: Complex Variable – Series representation (9 hours)

(Text 2- Relevant topics from sections 15.4,16.1, 16.2, 16.3)

Taylor's series and Maclaurin series. Laurent's series (without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, $\mathbf{44}^{th}$ edition 2018.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

Reference Books

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
1	**Partial Differential Equations**	**9**
1.1	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, equations solvable by direct integration.	3
1.2	Linear equations of the first order- Lagrange's linear equation. Non-linear equations of the first order - Charpit's method.	4
1.3	Boundary value problems, method of separation of variables.	2
2	**Applications of Partial Differential Equations**	**9**
2.1	One dimensional wave equation- vibration of a stretched string.	1
2.2	Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D' Alembert's solution of the wave equation.	3
2.3	One dimensional heat equation.	1
2.4	Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation.	4
3	**Complex Variable – Differentiation**	**9**
3.1	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations.	4
3.2	Harmonic functions, finding harmonic conjugate.	2
3.3	Conformal mappings- mappings of $w = z^2, w = e^z, w = \frac{1}{z}$.	3
4	**Complex Variable – Integration**	**9**
4.1	Complex integration, Line integrals in the complex plane, basic properties, First evaluation method, Second evaluation method, use of representation of a path.	4
4.2	Contour integrals, Cauchy integral theorem (without proof) on simply connected domain and on multiply connected domain (without proof).	2
4.3	Cauchy Integral formula (without proof).	2
4.4	Cauchy Integral formula for derivatives of an analytic function.	1
5	**Complex Variable – Series representation**	**9**
5.1	Taylor series and Maclaurin series.	2
5.2	Laurent's series (without proof).	3
5.3	Zeros of analytic functions, singularities, poles, removable singularities, essential singularities.	2
5.4	Residues.	2
	Total	**45 hours**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Form the partial differential equation given $z = f(x+it) + g(x-it)$ where $i = \sqrt{-1}$.
2. Solve $\frac{\partial^2 z}{\partial y^2}$ = sin (xy).
2. Solve $(y-z)p + (x-y)q = z - x$.
3. Solve $2zx - px^2$-2qxy +pq = 0.
4. Solve $\frac{\partial u}{\partial x} = 4\,\frac{\partial u}{\partial y}$ where u $u(0,y) = 8e^{-3y}$ by the method of separation of variables.

Course Outcome 2 (CO2):

1. A tightly stretched string of length 50cm has its ends fastened at $x = 0$ and $x = 50$ .The midpoint of the string is then taken to height h and then released from rest in that position. Find the initial position of the string.
2. Find the steady state temperature distribution in a rod of length 30cm if the ends are kept at 10^0C and 100^0C.
3. Write all possible solutions of one dimensional heat equation.
4. A string is stretched between the fixed points (0, 0) and (l, 0) and released at rest from the initial deflection given by $f(x) = \begin{cases} \frac{2k}{l}x\ ,\ when\ 0 < x < \frac{l}{2} \\ \frac{2k}{l}(l-x), when \frac{l}{2} < x < l \end{cases}$
5. A rod of length l with insulated sides is initially at a uniform temperature u_0.Its ends are suddenly cooled to 0^0C and are kept at that temperature. Find the temperature function $u(x,t)$.

Course Outcome 3(CO3):

1. Find the real and imaginary parts of the function $5z^2 - 12z + 3 + 2i$.
2. Check whether the function $\frac{x+iy}{x^2+y^2}$ is analytic.
3. Determine the analytic function whose real part is e^{2x}(xcos 2y – ysin2y).
4. Find the fixed points of $(a+ib)z^2$.
5. Find the image of $1 \le |z| \le 2$, $\frac{\pi}{6} \le \theta \le \frac{\pi}{3}$ under the mapping $w = z^2$.

Course Outcome 4 (CO4):

1. Evaluate $\int_0^{1+i}(x-iy)dz$ along the straight line path from 0 to 1+i.

2. Find the value of $\int_C \frac{z^2+1}{z^2-1} dz$where C is $|z-4-2i|$= 6.5.
3. Evaluate$\oint_C \frac{sinz}{z+4iz} dz$ where C is $|z| = 1$ in counterclockwise direction.
4. Evaluate $\oint_C \frac{\cos(\pi z^2)+\sin(\pi z^2)}{(z-1)(z-2)} dz$ where C is $|z| = 3$ using Cauchy's integral formula.
5. Integrate $\oint_C \frac{sinh2z}{\left(z-\frac{1}{2}\right)^4} dz$ in in counterclockwise direction around the unit circle.

Course Outcome 5 (CO5):

1. Find the Maclaurin series expansion of $\frac{z+2}{1-z^2}$.
2. Expand $f(z) = \frac{z+1}{z-1}$ as a Taylor series about $z = -1$.
3. Find the Laurent series of $\frac{-2z+3}{z^2-3z+2}$ valid in (i) $1 \le |z| \le 2$ (ii) $|z| \ge 2$.
4. Find all singular points and residue of the function $cosec\ z$.
5. Find the poles and residue of the function $\frac{1}{z^4-1}$.

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: B24MA2T03A

Course Name: COMPLEX VARIABLES AND APPLICATIONS OF PDE

Max.Marks:100 Duration:3hours

PARTA

Answer all questions. Each question carries 3marks.

1. Find the partial differential equation by eliminating arbitrary functions f and g from $z = f(x) + g(y)$.
2. Solve $\frac{\partial^2 z}{\partial x^2} = xy$.
3. Write the initial conditions and boundary conditions in which a tightly stretched string of length l with fixed end is initially in equilibrium position and is set vibrating by giving each point a velocity $v_0 sin^3\left(\frac{\pi x}{l}\right)$.
4. Find the steady state temperature distribution in a rod of length 25 cm, if the ends of the rod are kept at $20^0 C$ and $70^0 C$.
5. Test the continuity at $z = 0$ of $f(z) = \begin{cases} \frac{Re(z)}{1-|z|} & , z = 0 \\ 0 \quad , & z \neq 0 \end{cases}$
6. Show that an analytic function with constant real part is constant.
7. Evaluate$\oint_{-\pi i}^{\pi i} \cos z \, dz$.
8. Evaluate $\oint_C \frac{e^z}{z-3} dz$,where C is the circle $|z| = 4$.
9. Find the Maclaurin series of $\frac{1}{1+z^2}$.
10. Find the residue at poles for the function $f(z) = \frac{sinhz}{z^4}$.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11a. Form the partial differential equations by eliminating the arbitrary functions from $z = y\,f(x) + x\,g(y)$. (7)

b. Solve $(y + zx)p - (x + yz)q = x^2 - y^2$. (7)

OR

12a. Solve $q + xp = p^2$. (7)

b. Using method of separation of variables, solve $x^2 \frac{\partial u}{\partial x} + y^2 \frac{\partial u}{\partial y} = 0$. (7)

Module 2

13a. Solve one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ subject to $u(0,t) = 0$, $u(l,t) = 0, u(x,0) = 3\sin(2\pi x), \frac{\partial u}{\partial t}(x,0) = 0$. (7)

b. Solve the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ with boundary conditions $u(0,t) = 0^0 C, u(l,t) = 0^0 C$ and the temperature initially is $u(x,0) = x(l-x)$. (7)

OR

14a. A tightly stretched homogeneous string of length l with fixed ends at $x = 0$ and $x = l$ executes transverse vibrations. Motion starts with zero initial velocity by displacing the string into the form $f(x) = k(x^2 - x^3)$. Find the deflection u(x,t) at any time t. (7)

b. A homogeneous rod of heat conducting material of length l has its ends kept at zero temperature and the temperature initially is $u(x,0) = f(x)$. Find the temperature $u(x,t)$ at any time. (7)

Module 3

15a. Check whether $f(z) = iz\bar{z}$ is analytic. (7)

b. Find the image of $x > 1, y > 0$ under the transformation $w = \frac{1}{z}$. (7)

OR

16a. Show that $u = x^3 - 3xy^2 - 5y$ is harmonic. Also find the corresponding harmonic conjugate function. (7)

b. Find the image of $|z| \le \frac{1}{2}, \frac{-\pi}{8} < Arg z < \frac{\pi}{8}$ under the mapping $w = z^2$. (7)

Module 4

17a. Evaluate $\oint_C \left(z + \frac{1}{z}\right) dz$ where C is the unit circle traversed anti-clockwise. (7)

b. Evaluate $\oint_C \frac{5z+7}{z^2+2z-3} dz$ where C is taken counterclockwise around the circle

$i)$ $|z-2| = 2$ ii) $|z+i| = 1$. (7)

OR

18a. Evaluate $\int (z^2 + 3z)dz$ along the circle $|z| = 2$ from (2,0) to (0,2) in counter-clockwise direction. (7)

b. Integrate counterclockwise around the unit circle $\oint_C \frac{\sin(2z)}{z^4}\, dz$. (7)

Module 5

19a. Expand $f(z) = \frac{z-1}{z^2}$ as a Taylor series about $z_0 = 1$. (7)

b. Find the poles and residues of the function $\frac{1}{z^4-1}$. (7)

OR

20a. Determine and classify the singular points for the following functions:

i) $f(z) = \frac{sinz}{(z-\pi)^2}$

ii) $g(z) = (z+i)^2 e^{\left(\frac{1}{z+i}\right)}$. (7)

b. Expand $f(z) = \frac{z}{(z+1)(z+2)}$ as a Laurent's series about $z = -2$ in $0 < |z+2| < 1$. (7)

B24ME2T01	MECHANICS OF SOLIDS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course is designed to provide students with a thorough understanding of stress, strain, and their interrelation, enabling them to analyze and predict the mechanical behavior of materials across various real-world applications. It covers a wide range of topics, including axial loading, bending, torsion, strain energy, buckling, and failure theories—key concepts essential for designing safe and efficient structural components like beams, columns, shafts, and machinery. Through this course, students will gain the skills to comprehend internal forces within structures, predict their responses to different loading conditions, and make informed decisions about material selection, design criteria, and failure prevention. This foundational knowledge is crucial for multiple engineering fields, particularly civil, mechanical, and aerospace engineering, ensuring the safety, reliability, and longevity of engineering systems and structures.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply stress-strain relationships to determine the strength of materials under structural and thermal loading. (Cognitive Knowledge Level: Apply)
CO 2	Apply tensorial and Mohr's circle approaches to evaluate stresses, strains, and displacements in structural systems. (Cognitive Knowledge Level: Apply)
CO 3	Perform basic design of shafts subjected to torsional loading and apply principles of column stability to assess buckling behavior. (Cognitive Knowledge Level: Apply)
CO 4	Construct shear force and bending moment diagrams for beams under flexural loads and determine deflection of beams. (Cognitive Knowledge Level: Apply)
CO 5	Apply theories of failure in structural design and solve simple problems using energy methods. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	1		1						1
CO 2	3	3	2	2		1						1
CO 3	3	3	1	2		1						1
CO 4	3	3	1	2		1						1
CO 5	3	3	1	2		1						1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (10 hours)

Introduction to mechanics of deformable bodies, method of sections. Concept of stress and strain. Mechanical properties of materials, stress -strain curve for ductile and brittle materials. Hooke's law, constants of elasticity: Young's modulus, Shear modulus, Bulk modulus and Poisson's ratio. Relations between elastic constants. Constitutive relations for linearly elastic and isotropic materials.

Determination of stress and strain in bars of uniform cross sections subjected to axial loading, axial rigidity.

Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.

Simulate stress-strain behaviour of ductile and brittle materials using any analysis software.

MODULE 2 (10 hours)

Stress vectors on cartesian coordinate planes, stress tensor. Equality of cross shears. Cauchy's stress formula. Stress invariants, principal stresses and principal planes, maximum shear stress.

Analysis of strain, displacement field, strain tensor, strain compatibility equations.

Plane stress and plane strain conditions, Mohr's circle construction and problems for 2D case. Implement a code to construct Mohr's circle for a given stress state using any programming language.

MODULE 3 (8 hours)

Introduction to torsion of circular shafts, assumptions in theory of pure torsion, derivation of torsional formula. Torsional rigidity and polar section modulus. Strength and rigidity based design of hollow and solid circular shafts.

Introduction to elastic stability and buckling of columns, modes of failure of columns. Euler's buckling theory for long columns, slenderness ratio, Rankine's theory for short columns.

MODULE 4 (9 hours)

Beams- Classification and types of loadings, flexural formula, section modulus, flexural rigidity.

Shear Force and Bending Moment Diagrams. Differential equations between load, shear force and bending moment. Normal and shear stress in beams shear stress distribution for a rectangular section. Plot shear force, bending moment diagram, and identification of the bending stress, shear stress, and deflection distributions using any numerical analysis software/ programming language.

Deflection of beams using Macauley's method, Differential equation for elastic curve.

MODULE 5 (8 hours)

Introduction to Theories of Failure, Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain, Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy.

Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads.

Text Books

1. Mechanics of materials in S.I. units, R. C. Hibbeler, Pearson Higher Education 2018
2. Mechanics of Materials, F. Beer, E. R. Johnston, J. T. DeWolf, Tata McGraw Hill, 2020
3. Advanced Mechanics of Solids, L. S. Srinath, TMH
4. Strength of Materials, S.S. Rattan, McGraw Hill Education India, 2016

Reference Books

1. An introduction to the Mechanics of Solids, S. H. Crandal, N. C. Dhal, T. J. Lardner, McGraw Hill, 2008
2. Mechanics of Materials, James M. Gere, Stephen Timoshenko, CBS Publishers & Distributors, New Delhi,2012
3. Engineering Mechanics of Solids, E. P. Popov, Pearson Education, 2015
4. Mechanics of Materials, Pytel A. and Kiusalaas J. Cengage Learning India Private Limited, 2nd Edition, 2015

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**10**
1.1	Introduction to mechanics of deformable bodies, method of sections.	1
1.2	Concept of stress and strain. Mechanical properties of materials, stress -strain curve for ductile and brittle materials. Hooke's law	2
1.3	Constants of elasticity: Young's modulus, Shear modulus, Bulk modulus and Poisson's ratio.	1
1.4	Relations between elastic constants. Constitutive relations for linearly elastic and isotropic materials.	1
1.5	Determination of stress and strain in bars of uniform cross sections subjected to axial loading, axial rigidity	2
1.6	Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.	2
1.7	Simulate stress-strain behaviour of ductile and brittle materials using any numerical analysis software.	1
	Module 2	**10**
2.1	Stress vectors on cartesian coordinate planes, stress tensor.	2
2.2	Equality of cross shears. Cauchy's stress formula.	1
2.3	Stress invariants	1
2.4	Principal stresses and principal planes, maximum shear stress.	1
2.5	Analysis of strain and displacement field	1
2.6	Strain tensor, strain compatibility equations. Plane stress and plane strain conditions	1
2.7	Mohr's circle construction and problems for 2D case.	2

2.8	Implement a code to construct Mohr's circle for a given stress state using any programming language	1
	Module 3	**8**
3.1	Introduction to torsion of circular shafts, assumptions in theory of pure torsion, derivation of torsional formula.	1
3.2	Torsional rigidity and polar section modulus.	1
3.3	Strength and rigidity based design of hollow and solid circular shafts.	2
3.4	Introduction to elastic stability and buckling of columns	1
3.5	Modes of failure of columns. Euler's buckling theory for long columns	2
3.6	Slenderness ratio, Rankine's theory for short columns.	1
	Module 4	**9**
4.1	Beams – Classification and types of loadings, flexural formula, section modulus, flexural rigidity	1
4.2	Shear Force and Bending Moment Diagrams.	3
4.3	Differential equations between load, shear force and bending moment. Normal and shear stress in beams shear stress distribution for a rectangular section.	2
4.4	Plot shear force, bending moment diagram, and identification of the bending stress, shear stress, and deflection distributions using any numerical analysis software/ programming language.	1
4.5	Deflection of beams using Macauley's method, Differential equation for elastic curve.	2
	Module 5	**8**
5.1	Introduction to Theories of Failure, Rankine's theory for maximum normal stress	2
5.2	Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain	2
5.3	Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy.	2
5.4	Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads.	2
	Total	**45 hours**

KNOWLEDGE IS POWER

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Write the generalized Hooke's law for stress-strain relations.
2. Estimate the state of strain from a given state of stress.
3. Analyse the strength of a structure subjected to thermal loading.

Course Outcome 2 (CO2):

1. Determine the resultant traction at a point in a plane using the stress tensor.
2. Evaluate the principal stresses, principal strains and their directions from a given state of stress or strain.
3. Write the stress tensor and strain tensor.

Course Outcome 3 (CO3):

1. Design a shaft to transmit power and torque.
2. Compare strength of solid and hollow shafts.
3. Analyze a column for buckling load.

Course Outcome 4 (CO4):

1. Draw the shear force and bending moment diagrams.
2. Determine the bending stress on a beam subjected to pure bending.
3. Determine deflection of beams using Macauley's method.

Course Outcome 5 (CO5):

1. A bolt is subjected to a direct tensile load of 20 kN and a shear load of 15 kN. Suggest suitable size of this bolt according to various theories of elastic failure, if the yield stress in simple tension is 360 MPa. A factor of safety 2 should be used. Assume Poisson's ratio as 0.3.
2. Apply strain energy method to estimate the deformation of a structure.
3. Determine elastic strain energy for various loading conditions.

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24ME2T01**

Course Name: **MECHANICS OF SOLIDS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

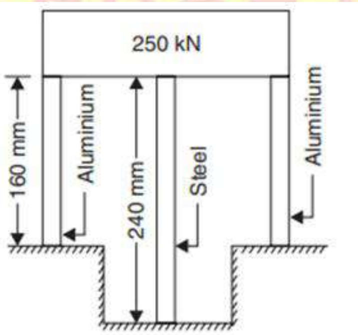
1) Explain Hooke's law for linearly elastic isotropic material.
2) Differentiate between engineering stress strain curve and true stress strain curve.
3) What are stress invariants? Why do they remain invariant?
4) Distinguish between plane stress and plane strain conditions by citing examples for each case.
5) Differentiate between section modulus and polar section modulus.
6) Define slenderness ratio. Explain the limitations of Euler's formula for long columns.
7) Draw the S.F and B.M. diagrams for a simply supported beam of length L carrying a clockwise couple of 'M' Nm at the midsection of the beam.
8) Explain the significance of flexural rigidity and section modulus in the analysis of beams.
9) Explain maximum distortion energy theory.
10) What is elastic strain energy?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11) Three pillars, two of aluminium and one of steel support a rigid platform of 250 kN as shown in figure. If the area of each aluminium pillar is 1200 mm^2 and that of steel pillar is 1000 mm^2, find the stresses developed in each pillar. Take $E_s = 2 \times 10^5$ N/mm^2 and $E_a = 1 \times 10^5$ N/mm^2.



(14 marks)

OR

12) A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar and the tube. Given: $E_s = 2 \times 10^5$ N/mm2, $E_b = 1 \times 10^5$ N/mm2 $\alpha s = 11.6 \times 10^{-6}$/°C and $\alpha b = 18.7 \times 10^{-6}$/°C. (14 marks)

Module 2

13) Determine the stress invariants, principal stresses and principal directions from the stress matrix at a point on a submarine hull given as follows: (14 marks)

$$\begin{bmatrix} 8 & 0 & 6 \\ 0 & 5 & 0 \\ 6 & 0 & -8 \end{bmatrix} \text{MPa}$$

OR

14) At a point in a bracket the stresses on two mutually perpendicular planes are 140 N/mm^2 and 70 N/mm^2 both tensile. The shear stress across these planes is 30 N/mm^2. Using the Mohr's stress circle determine the

i) principal stresses
ii) maximum shear stress
iii) principal planes and
iv) plane of maximum shear stress. (14 marks)

Module – 3

15) a) What are the assumptions taken while deriving Torsion equation (4 marks)

b) A solid aluminum shaft 1.5 m long and 60 mm diameter is to be replaced by a tubular steel shaft of the same length and the same outside diameter such that each of the two shafts could have the same angle of twist per unit torsional moment over the total length. What must the inner diameter of the tubular steel shaft be? Modulus of rigidity of the steel is three times that of aluminium. (10 marks)

OR

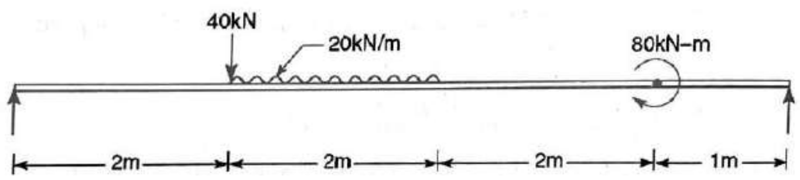
16) A 1.5 m long column has a circular cross section of 5 cm diameter. One of the ends of the column is fixed in direction and position and other end is free. Taking factor of safety as 3, calculate the safe load using

(i) Rankine's formula, take yield stress as 560 N/mm^2 and $\alpha = 1/1600$ for pinned ends and
(ii) Euler's Formula, Take E = 1.2 x10^5 N/mm^2. (14 marks)

Module – 4

17) Draw the shear force and bending moment diagrams for the simply supported beam shown in the figure. Calculate and locate the position of maximum bending moment.

(14 marks)



18) A simply supported beam of 8 m length carries two point loads of 64 kN and 48 kN at 1 m and 4 m, respectively, from the left-hand end. Find the deflection under each load and the maximum deflection using Macauley's method. Take E = 210 GPa and I = 180 × 10^6 mm^4.

(14 marks)

Module 5

19) Determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN. Using

   a. Maximum shear stress theory
   b. Maximum strain energy theory
   c. Maximum shear strain energy theory

Yield stress corresponding to elastic limit is 225 MPa, Factor of Safety = 3, and Poisson's ratio = 0.3

(14 marks)

OR

20) Derive an expression for the strain energy stored in an element having length L, flexural rigidity EI and Torsional rigidity GJ when subjected to under

a) Bending, M and

b) Torsion, T (14 marks)

KNOWLEDGE IS POWER

B24ME2T02	MECHANICS OF FLUIDS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course is designed to provide a comprehensive understanding of the fundamental properties and behaviors of fluids, which are essential to solving complex problems in engineering and related fields. This course will provide a solid foundation in the application of these concepts to real-world scenarios, particularly focusing on pipe flow systems, boundary layers, and the interaction between fluids and solid surfaces. The course also introduces key techniques such as dimensional analysis, which aids in simplifying complex fluid systems, and model testing, which allows for practical validation of theoretical predictions.

Prerequisites

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Understand the characteristics of fluids and solve hydrostatic problems. (Cognitive Knowledge Level: Understand)
CO 2	Understand different approaches to fluid kinematics and classify fluid flows. (Cognitive Knowledge Level: Understand)
CO 3	Apply Euler equation and Bernoulli's equation to the fluid flow problems. (Cognitive Knowledge Level: Apply)
CO 4	Apply principles of viscous and turbulent flow to analyze pipe flow behavior, frictional losses, energy transmission, and flow network efficiency. (Cognitive Knowledge Level: Apply)
CO 5	Apply the concept of boundary layer and dimensional analysis for model studies. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1						1			1
CO 2	3	2	1	1					1			1
CO 3	3	3	1	2					1			1
CO 4	3	3	2	1					1			1
CO 5	3	2	1	2					1			1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	40	10	10
Understand	60	30	30
Apply		60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

The end semester exam will carry 100 marks. There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (8 hours)

Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure- density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies.

MODULE 2 (9 hours)

Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow,1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, Irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines, flow nets, uses and limitations.

MODULE 3 (9 hours)

Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Dynamics of Fluid flow: Bernoulli's equation, Energies in flowing fluid, head, pressure, dynamic, static and total head, Venturi and Orifice meters, Notches and Weirs (description only). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot- static tube. Modern Flow measurement instruments.

MODULE 4 (9 hours)

Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen-Poiseuille equation. Turbulent flow: Darcy-Weisbach equation, Chezy's equation, Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes.

MODULE 5 (10 hours)

Boundary Layer: Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, separation of boundary and methods of control.

Dimensional Analysis: Dimensional analysis, Buckingham's theorem, important non dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynolds, Weber, Cauchy and Mach laws- Applications and limitations of model testing.

Text Books

1. John. M. Cimbala and Yunus A. Cengel, *Fluid Mechanics: Fundamentals and Applications*, McGraw Hill, 4^{th} ed., 2019.

2. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard and John W. Mitchell, *Fluid Mechanics*, Wiley India, 2018.
3. Subramanya K. *Fluid Mechanics and Hydraulic Machines*. McGraw-Hill Education, 2nd ed., 2018.
4. Bansal R. K. *A textbook of Fluid Mechanics and Hydraulic machines*, Laxmi Publications, 9th ed., 2019

Reference Books

1. White, F. M., *Fluid Mechanics*, McGraw Hill Education India Private Limited, 8th ed., 2017
2. Rathakrishnan, E. *Fluid Mechanics*: An Introduction, Prentice Hall India, 3rd ed., 2012.

COURSE CONTENTS AND LECTURE SCHEDULE

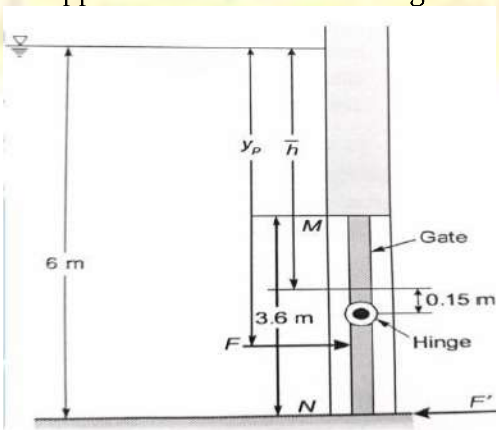
No	Topic	No. of Lectures/ Tutorial hours
	Module 1	**8**
1.1	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure.	2
1.2	Newton’s law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids.	2
1.3	Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces.	2
1.4	Center of pressure, buoyancy, stability of immersed and floating bodies.	2
	Module 2	**9**
2.1	Kinematics of fluid flow: Eulerian and Lagrangian approaches.	2
2.2	Classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, nonuniform, laminar, turbulent, rotational, irrotational flows.	2
2.3	Stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid.	2
2.4	Circulation and vorticity, stream function and potential function.	2
2.5	Laplace equation, equipotential lines, flow nets, uses and limitations.	1
	Module 3	**9**
3.1	Control volume analysis of mass, momentum and energy, Equations of fluid dynamics.	2
3.2	Differential equations of mass, energy and momentum (Euler’s equation).	1
3.3	Dynamics of Fluid flow: Bernoulli’s equation.	2
3.4	Energies in flowing fluid, head, pressure, dynamic, static and total head, Venturi and Orifice meters.	2
3.5	Notches and Weirs (description only for notches and weirs) Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-	2

	static tube.	
	Module 4	**9**
4.1	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number critical Reynolds number.	2
4.2	Shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen-Poiseuille equation.	2
4.3	Turbulent flow: Darcy-Weisbach equation, Chezy's equation, Moody's chart.	2
4.4	Major and minor energy losses, hydraulic gradient and total energy line.	2
4.5	Flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission.	1
	Module 5	**10**
5.1	Boundary Layer: Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness.	2
5.2	Laminar and turbulent boundary layers, laminar sub layer, velocity profile.	1
5.3	Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	2
5.4	Dimensional Analysis: Dimensional analysis, Buckingham's theorem, important non dimensional numbers and their significance.	2
5.5	Geometric, Kinematic and dynamic similarity, model studies.	2
5.6	Froude, Reynolds, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only.	1
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. A 3.6 x 1.5 m wide rectangular gate MN is vertical and is hinged at point 0.15 m below the center of gravity of the gate. The total depth of water is 6 m. What horizontal force must be applied at the bottom of the gate to keep the gate closed.



2. A stationary liquid is stratified so that its density is $\rho_0(1+h)$ at a depth h below the free surface. At a depth h in this liquid, what is the pressure in excess of $\rho_0 gh$?
3. If the velocity profile of a fluid is parabolic with free stream velocity 120 cm/s occurring at 20 cm from the plate, calculate the velocity gradients and shear stress at a distance of 0, 10, 20 cm from the plate. Take the viscosity of fluid as 8.5 poise.

Course Outcome 2 (CO2):

1. Differentiate between Eulerian and Lagrangian method of representing fluid motion.
2. A velocity field is given by $u=3y^2$, $v=2x$ and $w = 0$ in arbitrary units. Is this flow steady or unsteady? Is it two or three dimensional?

   At (x, y, z) = (2,1,0), compute

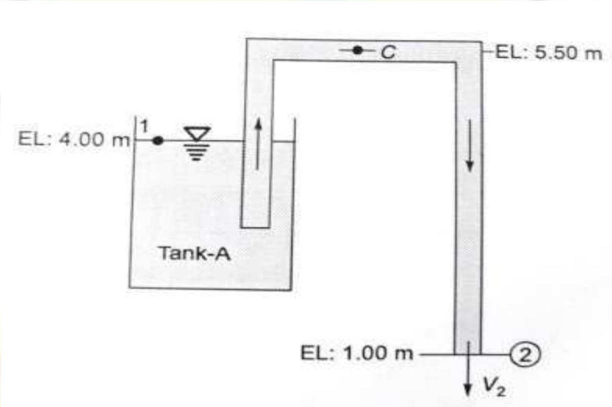
   (a) velocity

   (b) local acceleration

   (c) convective acceleration
3. A stream function in two-dimensional flow is $\Psi = 2xy$. Show that the flow is irrotational and determine the corresponding velocity potential ϕ.

Course Outcome 3 (CO3):

1. A siphon consisting of a pipe of 15 cm diameter is used to empty kerosene oil (relative density=0.8) from tank A. The siphon discharges to the atmosphere at an elevation of 1.00 m. The oil surface in the tank is at an elevation of 4.00 m. The center line of the siphon pipe at its highest point C is at an elevation of 5.50 m.



   Estimate,

   (a) Discharge in the pipe

   (b) Pressure at point C

   The losses in the pipe can be assumed to be 0.5 m up to the summit and 1.2 m from summit to the outlet.
2. Derive the Euler's equation of motion along a streamline and from that derive the Bernoulli's equation.
3. What is Venturi meter? Derive the expression for Coefficient of discharge for Venturi meter

Course Outcome 4 (CO4):

1. Two reservoirs with a difference in water surface elevation of 10 m are connected by a pipeline AB and BC joined in series. Pipe AB is 10 cm in diameter,20 m long and has a value of friction factor, f = 0.02. Pipe BC is 16 cm diameter, 25 m long and has a friction factor f=0.018. The junctions with reservoirs and between pipes are abrupt.

   (a) Sketch Total energy line and Hydraulic gradient line

   (b) Calculate the discharge

2. Oil of viscosity 0.1 Pa.s and specific gravity 0.9 flows through a horizontal pipe of 25mm diameter.

   If the pressure drop per meter length of the pipe is 12 KPa, determine

   (a) Discharge through the pipe

   (b) Shear stress at the pipe wall

   (c) Reynolds number of the flow

   (d) Power required in Watts if the length of the pipe is 50m.

3. In a hydraulic power plant, a reinforced concrete pipe of diameter D is used to transmit water from the reservoir to the turbine. If H is the total head supply at the entrance of the pipe and hf is the loss of head in the pipe, then derive the condition for maximum power supply through the pipe.

Course Outcome 5 (CO5)

1. Write a short note on boundary layer separation and discuss any two methods to control the same.

2. Explain the importance of dimensionless numbers and discuss any two similarity laws. Where are these model laws used?

3. A thin plate is moving in still atmospheric air at a velocity of 4m/s. The length of the plate is 0.5m and width 0.4 m. Calculate the

   (a) thickness of the boundary layer at the end of the plate and

   (b) drag force on one side of the plate.

   Take density of air as 1.25 kg/m^3 and kinematic viscosity 0.15 stokes.

MODEL QUESTION PAPER

QP CODE: Pages: 4

Reg. No.: ....

Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24ME2T02**

Course Name: **MECHANICS OF FLUIDS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1 The specific gravity of a liquid is 3.0. What is its specific weight, specific mass, specific volume?

2 State Pascal's law and give some examples where this principle is used.

3 Explain Streamlines, Streak lines and Path lines.

4 What do you understand by the terms: (i) Total acceleration, (ii) Convective acceleration, and (iii) Local acceleration?

5 Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into consideration.

6 Differentiate between pitot tube and pitot static tube.

7 Define and explain the terms (i) Hydraulic gradient line and (ii) Total energy line.

8 Show that the coefficient of friction for viscous flow through a circular pipe is given by $f = \frac{16}{Re}$

where Re is the Reynolds number.

9 What do you mean by repeating variables? How repeating variables are selected for dimensional analysis.

10 How will you determine whether a boundary layer flow is attached flow, detached flow or on the verge of separation.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11 a. Through a very narrow gap of height h, a thin plate of large extend is pulled at a velocity V. On one side of the plate is oil of viscosity $\mu 1$ and on the other side oil of viscosity $\mu 2$. Calculate the position of the plate so that

a. the shear force on the two sides of the plate is equal.
b. the pull required to drag the plate is minimum.

Assume linear velocity distribution in transverse direction. (7 marks)

b. A metallic cube of 30 cm side and weight 500 N is lowered into a tank containing two fluid layers of water and mercury. Top edge of the cube is at water surface. Determine the position of the block at water mercury interface when it has reached equilibrium. (7 marks)

OR

12 a. A rectangular tank 1.5 m wide, 3 m long and 1.8 m deep contains water to a depth of 1.2 m. Find the horizontal acceleration which may be imparted to the tank in the direction of length so that

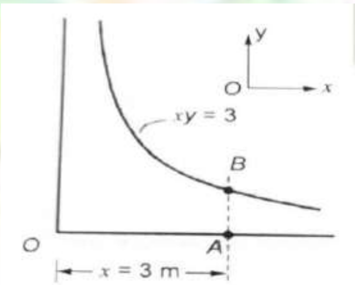
i. there is just no spilling from the tank.
ii. front bottom corner of the tank is just exposed.

(7 marks)

b. A spherical water drop of 1 mm diameter splits up in air into 64 smaller drops of equal size. Find the work required in splitting up the drop. The surface tension coefficient of water in air = 0.073 *N/m* (7 marks)

Module 2

13 If the coefficient of static friction equals 0.3 for all surfaces of contact, determine the smallest value of force P necessary to raise the block A of mass 300kg. Neglect the weight of the wedge B. Angle of wedge is 10°.



Calculate

i. Velocity at B
ii. Convective acceleration at B
iii. Flow per unit width across AB

(14 marks)

OR

14 a. Consider the velocity field given by u = x^2 and v = 2xy. Find the circulation around the area bounded by A (1,1), B (2,1), C (2,2), D (1,2). (4 marks)

b. Verify whether the following are valid potential functions.

i. $\phi = 2x + 5y$
ii. ii. $\phi = 4x^2 - 5y^2$ (10 marks)

Module 3

15 a. A submarine moves horizontally in sea and has its axis 15 m below the surface of the water. A pitot tube properly placed just in front of the submarine and along its axis is

connected to two limbs of a U tube containing mercury. The difference of level is found to be 170 mm. Find the speed of the submarine knowing that the specific gravity of mercury is 13.6 and that of sea water is 1.026 with respect to water. (7 marks)

b. A pitot tube is inserted in a pipe of 30 cm diameter. The static pressure of the tube is 10 cm of mercury vacuum. The stagnation pressure at the centre of the pipe recorded by the pitot tube is 1.0 N=cm^2. Calculate the rate of flow of water through the pipe, if the mean velocity of flow is 0.85 times central velocity. Assume coefficient of tube as 0.98. (7 marks)

OR

16 a. A smooth pipe of uniform diameter 25 cm, a pressure of 50 KPa was observed at section 1 which has an elevation of 10 m. At another section 2, at an elevation of 12 m, the pressure was 20 KPa and the velocity was 1.25 m/s. Determine the direction of flow and the head loss between the two sections. The fluid in the pipe is water. (7 marks)

b. Petrol of specific gravity 0.8 is following through a pipe of 30 cm diameter. The pipe is inclined at 30° to horizontal. The venturi has a throat diameter of 10 cm. U tube manometer reads 6.25 cm Hg. Calculate the discharge through the pipe. Assume Cd = 0.98. (7 marks)

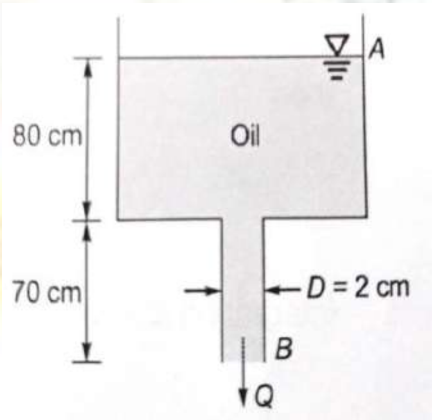
Module 4

17 a. Assuming viscous flow through a circular pipe derive the expression for,

i. Velocity distribution
ii. Shear stress distribution

Also plot the velocity and shear stress distribution. (7 marks)

b. A large tank shown in the figure has a vertical pipe 70 cm long and 2 cm in diameter. The tank contains oil of density 920 Kg/m^3 and viscosity 1.5 poise. Find the discharge through the tube when the height of oil level of the tank is 0.80 m above the pipe inlet. (7 marks)



OR

18 a. A compound piping system consist of 1800 m of 50 cm, 1200 m of 40 cm and 600 m of 30 cm diameter pipes of same material connected in series.

i. What is the equivalent length of a 40 cm pipe of same material?
ii. What is the equivalent diameter of a pipe 3600 m long?
iii. If three pipes are in parallel what is equivalent length of 50 cm pipe?

(10 marks)

b. A pipe line of 2100 m is used for transmitting 103 KW. The pressure at the inlet of the pipe is 392.4N/cm^2. If the efficiency of transmission is 80%, and the diameter of the pipe. Take f = 0.005 (4 marks)

Module 5

19 The pressure difference Δp in a pipe of diameter D and length l due to turbulent flow depends on the velocity V, viscosity μ, density ρ and roughness k. Using Buckingham's π-theorem, obtain an expression for Δp. (14 marks)

OR

20 Derive expressions for the displacement, momentum and energy thickness in connection with the boundary layer theory. (14 marks)

B24ME2T03	METALLURGY & MATERIAL SCIENCE	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble

This course is designed to provide students with a strong understanding of the fundamental principles of mechanics. It explores the relationship between the chemical bonds and crystal structure of metallic materials to their mechanical properties. Students will gain insight into the significance of crystal imperfections, including dislocations, in plastic deformation. The course also covers various phases and heat treatment techniques used to modify the properties of Fe-C alloys. Additionally, students will analyze material failure mechanisms such as fatigue and creep and learn to determine the properties of unknown materials, fostering an awareness of their application in material design.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Understand the basic chemical bonds, crystal structures (BCC, FCC, and HCP), and their relationship with the properties. (Cognitive Knowledge Level: Understand)
CO 2	Understand the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments. (Cognitive Knowledge Level: Understand)
CO 3	Quantify mechanical integrity and failure in materials. (Cognitive Knowledge Level: Apply)
CO 4	Apply the basic principles of ferrous and non-ferrous metallurgy for selecting materials for specific applications. (Cognitive Knowledge Level: Apply)
CO 5	Define and differentiate engineering materials on the basis of structure and properties for engineering applications. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2		1			1						1
CO 2	1		2		2							1
CO 3	2		2			1						1
CO 4	2		1			1						2
CO 5	2		1									1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
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Apply		60	60
Analyse			
Evaluate			
Create			

Mark distribution

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End Semester Examination Pattern

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SYLLABUS

MODULE 1 (7 hours)

Atomic structure – Types of bonds: Crystallography: - SC, BCC, FCC, HCP structures, APF - theoretical density (include problems) – Miller Indices: - crystal plane and direction - Modes of plastic deformation: - Slip and twinning -Schmid's law - Crystallization: Effects of grain size, Hall - Petch theory, simple problems.

MODULE 2 (8 hours)

Classification of crystal imperfections - forest of dislocation, role of surface defects on crack initiation- Burgers vector Frank Read source – Correlation of dislocation density with strength and nano concept - high and low angle grain boundaries - driving force for grain growth and applications – Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.

MODULE 3 (8 hours)

Phase diagrams: - need of alloying - classification of alloys – Hume Rothery`s rule – equilibrium diagram of common types of binary systems: five types - Coring - lever rule and Gibb`s phase rule - Reactions- Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties -Heat treatment: - TTT, CCT diagram, applications - Tempering- Hardenability, Jominy end quench test, applications- Surface hardening methods.

MODULE 4 (7 hours)

Strengthening mechanisms - cold and hot working - alloy steels: how alloying elements affecting properties of steel - nickel steels - maraging steel- chromium steels - high speed steels - Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.

MODULE 5 (6 hours)

Fracture- type of fracture- Ductile Fracture, Brittle Fracture and Fatigue Fracture, DBTT - Definition and Significance, Factors Influencing DBTT, Fatigue: - Creep - Super plasticity - Super alloy- Types of Superalloys (Nickel-based, Cobalt-based, Iron-based), Intermetallic, Titanium - need, properties and applications of composites, Smart Materials-Properties and applications.

Text Books

1. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill, 2009.

2. Anderson J.C. et.al., Material Science for Engineers, Chapman and Hall, 1990.

Reference Books

1. William D. Callister Jr. and David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley 2013.

2. Clark and Varney, Physical metallurgy for Engineers, Van Nostrand, 1964.
3. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill, 1976.
4. Raghavan V, Material Science and Engineering, Prentice Hall, 2004.
5. Reed Hill E. Robert, Physical metallurgy principles, 4th edition, Cengage Learning, 2009.
6. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press, 2008.
7. Van Vlack -Elements of Material Science - Addison Wesley, 1989.
8. https://nptel.ac.in/courses/113/106/113106032

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**7**
1.1	Atomic structure – Types of bonds: Crystallography: - SC, BCC, FCC, HCP structures	1
1.2	APF - theoretical density (include problems)	2
1.3	Miller Indices: - crystal plane and direction - Modes of plastic deformation	1
1.4	Slip and twinning -Schmid's law - Crystallization	1
1.5	Effects of grain size, Hall - Petch theory, simple problems.	2
	Module 2	**8**
2.1	Classification of crystal imperfections - forest of dislocation, role of surface defects on crack initiation	1
2.2	Burgers vector Frank Read source – Correlation of dislocation density with strength and nano concept	1
2.3	high and low angle grain boundaries - driving force for grain growth and applications	2
2.4	Diffusion in solids, Fick’s laws, mechanisms	2
2.5	Applications of diffusion in mechanical engineering, simple problems.	2
	Module 3	**8**
3.1	Phase diagrams: - need of alloying - classification of alloys	1
3.2	Hume Rothery`s rule – equilibrium diagram of common types of binary systems	1
3.3	Five types - Coring - lever rule and Gibb`s phase rule - Reactions- Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties	2
3.4	Heat treatment: - TTT, CCT diagram, applications	2
3.5	Tempering- Hardenability, Jominy end quench test, applications- Surface hardening methods	2
	Module 4	**7**
4.1	Strengthening mechanisms - cold and hot working	1

4.2	Alloy steels: how alloying elements affecting properties of steel	2
4.3	Nickel steels - maraging steel- chromium steels - high speed steels	1
4.4	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc	2
4.5	Composition, microstructure, properties and applications	1
	Module 5	**6**
5.1	Fracture- type of fracture, Ductile Fracture, Brittle Fracture and Fatigue Fracture	1
5.2	DBTT Definition and Significance, Factors Influencing DBTT, Fatigue Creep	1
5.3	Super alloy- Types of Superalloys - Intermetallic, Titanium	1
5.4	Need, properties and applications of composites	2
5.5	Smart Materials-Properties and applications.	1
Additional topics: The students may be encouraged to pursue topics related to material science like use of Nano materials to improve the mechanical properties and also on the common materials used in industry.		
	Total	**36 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

Understand the basic chemical bonds, crystal structures (BCC, FCC, and HCP), and their relationship with the properties.

1. What are the attributes of atomic and crystalline structures into the stress - strain curve?
2. Explain the significance of long range and short range order of atomic arrangement on mechanical strength.
3. What is the difference between an allotrope and a polymorphism?
4. Draw the (112) and (111) planes in simple cubic cell.

Course Outcome 2 (CO2):

Analyze the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments.

1. What is the driving force for recrystallisation and grain growth of metallic crystals?
2. What is the driving force for the formation of spheroidite.
3. What is tempered martensite?
4. Why 100 % pure metals are weak in strength?

Course Outcome 3 (CO3):

How to quantify mechanical integrity and failure in materials

1. A small hole is drilled through a steel plate ahead of a crack, whether it can stop the crack's progress until repairs can be made. Explain in detail and derive the equation for the principle.
2. Draw and explain S-N curves for ferrous and non-ferrous metals. Explain different methods to improve fatigue resistance.
3. Explain different stages of creep; Give an application of creep phenomenon. What is superplasticity?

Course Outcome 4 (CO4):

Apply the basic principles of ferrous and non-ferrous metallurgy for selecting materials for specific applications.

1. What are the classification, compositions and applications of high speed steel? identify 18:4:1
2. Describe the composition, properties, and use of Bronze and Gun metal.
3. Explain the importance of all the non-ferrous alloys in automotive applications. Elaborate on the composition, properties and typical applications of any five non-ferrous alloys.

Course Outcome 5 (CO5):

Define and differentiate engineering materials on the basis of structure and properties for engineering applications.

1. Carbon is allowed to diffuse through a steel plate 15 mm thick. The concentrations of carbon at the two faces are 0.65 and 0.30kgC/m3Fe, which are maintained constant. If the preexponential and activation energy are 6.2x10-7m2/s and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is 1.43 x 10-9 kg/m2-s.
2. Explain the fundamental effects of alloying elements in steel on polymorphic transformation temperatures, grain growth, eutectoid point, retardation of the transformation rates, formation and stability of carbides.
3. Describe the kind of fracture which may occur as a result of a loose fitting key on a shaft.

MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No. : ....

Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

***Course Code:* B24ME2T03**

***Course Name:* METALLURGY & MATERIAL SCIENCE**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. What is a slip system? Describe the slip systems in FCC, BCC and HCP metals
2. NASA's Parker Solar Probe will be the first-ever mission to "touch" the Sun. The spacecraft, about the size of a small car, will travel directly into the Sun's atmosphere about 4 million miles from the earth surface. Postulate the coolant used in the parker solar probe with chemical bonds.
3. What is the driving force for grain growth during heat treatment
4. What are the roles of surface imperfections on crack initiation
5. Explain the difference between hardness and hardenability.
6. What is tempered martensite? Explain its structure with sketch.
7. Postulate, why cast irons are brittle?
8. How are properties of aluminum affected by the inclusion of (a) copper and (b) silicon as alloying elements?
9. What is the grain size preferred for creep applications? Why. Explain thermal fatigue?
10. Explain fracture toughness and its attributes into a screw jack?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) Calculate the APF of SC, BCC and FCC. (7 marks)

b) What is slip system and explain why FCC materials exhibit ductility and BCC and HCP exhibit brittle nature with details of slip systems. (7 marks)

OR

12. Explain the effect of: (i) Grain size; (ii) Grain size distribution and (iii) Grain orientation (iv) Grain shape on strength and creep resistance with neat sketches. Attributes of Hall-Petch equation and grain boundaries. (14 marks)

Module 2

13. a) Describe step by step procedure for metallographic specimen preparation? Name different types etchants used for specific metals and methods to determine grain size. (7 marks)

    b) Carbon is allowed to diffuse through a steel plate 15 mm thick. The concentrations of carbon at the two faces are 0.65 and 0.30 kgC/ m^3Fe, which are maintained constant. If the preexponential and activation energy are 6.2×10^{-7} m^2 /s and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is 1.43×10^{-9} kg/m^2-s. (7 marks)

OR

14. a**)** Explain the fundamental differences of SEM and TEM with neat sketches. (7 marks)

    b**)** A beam of X-rays wavelength 1.54Å is incident on a crystal at a glancing angle of $8^{o}35^{'}$ when the first order Bragg's reflection occurs calculate the glancing angle for third order reflection. (7 marks)

Module 3

15. Postulate with neat sketches, why 100% pure metals are weaker? What are the primary functions of alloying? Explain the fundamental rules governing the alloying with neat sketches and how is it accomplished in substitution and interstitial solid solutions. (14 marks)

OR

16. Draw the isothermal transformation diagram of eutectoid steel and then sketch and label (1) A time temperature path that will produce 100% pure coarse and fine pearlite (2) A time temperature path that will produce 50% martensite and 50% bainite (3) A time temperature path that will produce 100% martensite (4) A time temperature path that will produce 100% bainite. (14 marks)

Module 4

17. Explain the effect of, polymorphic transformation temperature, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement of corrosion resistance on adding alloy elements to steel. (14 marks)

OR

18. Give the composition, microstructure, properties and applications of (i) Gray iron and SG iron. (ii) White iron and Gray iron. (iii) Malleable iron and Gray iron. (iv) Gray iron and Mottled iron, (v) SG iron and Vermicullar Graphite Iron. (14 marks)

Module 5

19. a) A small hole is drilled through a steel plate ahead of a crack, whether it can stop the crack's progress until repairs can be made or not? Explain in detail and derive the equation. (7 marks)

    b) What is ductile to brittle transition in steel DBTT? What are the factors affecting ductile to brittle transition? Narrate with neat sketch. (7 marks)

OR

20. Classify ceramics with radius ratio with neat sketches. Explain with an example for each of the AX, AmXp, AmBmXp type structures in ceramics with neat sketch. (14 marks).

B24HU2T02	ENTREPRENEURSHIP AND MANAGEMENT SKILLS FOR ENGINEERS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	1	0	2	3	2024

Preamble: In today's rapidly evolving world, engineers must go beyond technical expertise and develop entrepreneurial, managerial, and business acumen to drive innovation and create impact. This course equips students to identify opportunities, develop scalable business models, and apply modern management and marketing strategies. Through activity-based learning, case studies, and real-world problem-solving, students will gain practical insights into leadership, business analysis, and intellectual property rights (IPR), preparing them for startups, corporate leadership, and innovation-driven industries.

Prerequisite

Nil.

Course Outcomes

By the end of this course, students will be able to:

CO 1	Understand key principles and functions of management to grasp modern managerial roles (Cognitive Knowledge Level: Understand)
CO 2	Explain the fundamentals of managing people and processes through effective staffing, motivation, leadership, and control strategies. (Cognitive Knowledge Level: Understand)
CO 3	Apply modern marketing strategies and digital transformation to build sustainable businesses. (Cognitive Knowledge Level: Apply)
CO 4	Understand the basics of idea pitching, managing finances and using modern marketing tools. (Cognitive Knowledge Level: Understand)
CO 5	Understand Intellectual Property Rights (IPR) and legal frameworks to protect innovation and navigate startup challenges. (Cognitive Knowledge Level: Understand)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						1		1	1	1	2	2
CO 2						1		1	2	2	2	2
CO 3											3	2
CO 4											2	2
CO 5						1	1			1	2	2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	40	30	30
Understand	60	50	50
Apply		20	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Case studies/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (6 Hours)

Functions of Management: Introduction to Management: Definitions and scope - Core Functions - Levels of Management - Evolution of Management Thought: Scientific Management (F.W. Taylor), Administrative Management (Henri Fayol), Modern Approaches - Planning and Types of Plans - Organizational Structures: Departmentalization.

MODULE 2 (7 Hours)

Manpower Planning, Leadership & Control:
Staffing - Motivation Theories – Leadership - Understanding Negotiation in Leadership: Types of Negotiation – Barriers to effective communication - Activity-based learning.

MODULE 3 (8 Hours)

Entrepreneurial Thinking & Business Design:
Entrepreneurial Mindset: Growth mindset, risk-taking, and decision-making - Finding a Good Business Idea - How to prepare an Empathy canvas, Value proposition canvas and Idea canvas - Digital Business Models: Freemium, Subscription, Platform-based - Business Model Canvas: Develop and visualise the business model.

MODULE 4 (6 Hours)

Startup Pitching, Marketing & Financials:
Startup Financials: Revenue models, cost structure, funding stages, valuation basics - Investor Pitching: Structure of a pitch deck, communicating value, funding strategy - Digital branding, social media, performance marketing - Growth Strategies: Network effects, influencer marketing, CRM tools.

MODULE 5 (9 Hours)

Intellectual Property Rights (IPR) and Legal Framework
Overview of Intellectual Property Rights (IPR) - Product patents, Process patents- Prerequisites for filing a patent: Novelty, Inventive step, Industrial applicability -Provisional vs Complete application - Common mistakes to avoid before filing - Anatomy of a Patent Document - Overview of databases - Legal Aspects of Startups- Business Registrations and Legal structures – Compliance & Regulatory Requirements.

Reference Books

1. Ricky W. Griffin, Jean M. Phillips & Stanley M. Gully, *Organizational Behavior: Managing People and Organizations*, Cengage Learning, 12th Edition, 2019.
2. Stephen P. Robbins & Timothy A. Judge, *Organizational Behavior*, Pearson Education, 18th Edition, 2019.
3. Heidi M. Neck, Christopher P. Neck & Emma L. Murray, *Entrepreneurship: The Practice and Mindset*, SAGE Publications Inc., 3rd Edition, 2023.
4. Alejandro Cremades, *The Art of Startup Fundraising: Pitching Investors, Negotiating the Deal, and Everything Else Entrepreneurs Need to Know*, Wiley, 2023.
5. Dr R. Radhakrishnan & Dr S. Balasubramanian, *Intellectual Property Rights: Text and Cases*, Excel Books, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1 (6 Hours)	
1.1	Introduction to Management: Definitions and scope - Core Functions: Planning, Organizing, Staffing, Directing, Controlling. - Levels of Management: Top, Middle, Lower.	1
1.2	Evolution of Management Thought: Classical approaches -F.W. Taylor, Henri Fayol - Modern Approaches: Systems approach, Contingency approach.	1
1.3	Planning: Importance and steps in planning (objectives, alternatives, evaluation, selection). Types of plans: Strategic, Tactical, Operational, Contingency.	2
1.4	Organizational Structure, Types of Organizational Structures: Functional, Divisional, Matrix, Flat vs. Tall Organizations, Impact of Structure on Business Operations.	2
	Module 2 (7 Hours)	
2.1	Manpower Planning, Job Analysis, Recruitment vs Selection - Motivation Theories: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory.	2
2.2	Leadership theories: Theory X and Theory Y- Leadership Styles: Autocratic, Democratic, Laissez-faire - Application and effectiveness in various organizational contexts.	2
2.3	Understanding Negotiation in Leadership: Types of Negotiation: Distributive vs. Integrative, Understanding when to compete and when to collaborate. Team building.	2
2.4	Communication Types: Formal and Informal - Barriers to effective communication. Communication distortion. Case studies.	1
Activity-Based Learning: Leadership Roll Playing Simulation: Real-life negotiation scenarios such as investor discussions or conflict resolution between co-founders to practice persuasive communication and strategic thinking.		
	Module 3 (8 hours)	
3.1	Entrepreneurial Mindset – Growth mindset, risk-taking, and decision-making.	2
3.2	Finding a Good Business Idea - Looking around for real-life problems people face. How to prepare an Empathy canvas, value proposition canvas and Idea canvas.	2
3.3	Planning Your Business on One Page - Use a simple chart called the Business Model Canvas.	2
3.4	How Online Businesses Make Money - Freemium Model (Free basic version, pay for extra features) - Subscription Model (Monthly/Yearly payments for continuous use) - Platform Model (Connecting buyers and sellers, like Amazon or Swiggy).	2
Activity: The students may be encouraged to make a Business model plan of their choice.		

Module 4 (6 Hours)		
3.1	Startup financials - Key Financial Terms**:** Revenue, cost, profit, cash flow, gross margin, net profit, burn rate, turnover, ask - Types of Revenue Models, cost structure, funding stages, valuation basics.	2
3.2	Investor Pitching – Structure of a pitch deck, communicating value, and funding strategy.	2
3.3	Modern Marketing – Digital branding, social media, performance marketing - Growth Strategies: Network effects, influencer marketing, CRM tools.	2
Module 5 (9 Hours)		
5.1	Overview of Intellectual Property Rights (IPR) - What is a patent and why does it matter - Types of patentable subject matter: Product Patents, Process Patents- Prerequisites for filing a patent: Novelty, Inventive step, Industrial applicability.	2
5.2	Provisional vs Complete application - When to file a patent (timing strategy for start-ups) - Common mistakes to avoid before filing (e.g., disclosing ideas publicly)	1
5.3	Anatomy of a Patent Document: Title, Abstract, Background, Claims, Drawings - Indian vs International Patents: Filing paths and differences (PCT vs national phase) - Overview of databases: Google Patents, USPTO, WIPO, Espacenet.	2
5.4	Business Registrations & Legal Structures - Types of business entities: Sole Proprietorship, Partnership, LLP, Private Ltd, OPC. Startup India Registration – Benefits & Eligibility.	2
5.5	Compliance & Regulatory Requirements - GST Registration, ROC Filings. Startup Taxation & Incentives. Taxes applicable to startups (Income Tax, GST, TDS, Angel Tax). Tax Benefits for Startups under Section 80-IAC & DPIIT.	2
	Total	**36 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 CO1):

1. Explain the core functions of management and how they support effective organizational operations.
2. How do different levels of management (top, middle, lower) contribute to achieving business goals?
3. Explain the difference between classical and modern approaches to management thought.

Course Outcome 2 (CO2):

1. How do Maslow's Hierarchy of Needs and Herzberg's Two-Factor theory explain employee motivation in the workplace?
2. Enumerate the key differences between Theory X, Theory Y, and Theory Z, and how they influence leadership styles.

3. How do BATNA and ZOPA help leaders make effective negotiation decisions during team conflicts or business deals?

Course Outcome 3 (CO3):

1. Use the Business Model Canvas to design a simple online learning platform. Include key elements such as customer segments, revenue model, and value proposition.
2. Prepare an Idea Canvas for a mobile app that helps local farmers sell directly to customers. Explain how this solution fits a real-world problem.
3. Choose one digital business model (freemium, subscription, or platform-based) and apply it to a startup idea of your choice. Explain how this model supports long-term business sustainability.

Course Outcome 4 (CO4):

1. Explain the key components of a startup pitch deck and their role in communicating value to investors.
2. Describe the difference between a revenue model and a cost structure, and why both are important in startup financial planning.
3. What is digital branding, and how can tools like social media and influencer marketing help a new business grow?

Course Outcome 5 (CO5):

1. Discuss the key differences between product patents and process patents.
2. Explain the basic prerequisites for filing a patent.
3. List any three types of legal business structures in India and describe how choosing the right structure supports startup compliance.

Model Question Paper

QP CODE: Pages: 3

Reg No.:____________________

Name:______________________

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B. TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24HU2T02**

Course Name: **ENTREPRENEURSHIP AND MANAGEMENT SKILLS FOR ENGINEERS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Define the core functions of management with a brief explanation.
2. Differentiate between flat and tall organisational structures.
3. Explain the key difference between Maslow's and Herzberg's motivation theories.
4. Differentiate between distributive and integrative negotiation with one example each.
5. List any three key components of the Business Model Canvas and explain their purpose.
6. Explain the concept of a growth mindset in the context of entrepreneurship.
7. State the meaning of 'burn rate' and why it is important for startups.
8. Mention any two components of a startup pitch deck and explain their importance.
9. State the difference between a provisional and a complete patent application.
10. List any two legal compliance requirements for a startup after registration.

PART B

Answer any one question from each module. Each question carries 14 marks.

MODULE 1

11a. Illustrate the three levels of management with suitable examples and describe the role of each in organizational decision-making. (7 Marks)

b. Discuss the different types of plans (strategic, tactical, operational, contingency) with examples, and explain how they guide managerial actions. (7 Marks)

OR

12a. Explain the five core functions of management and discuss their importance in running a business efficiently. (7 Marks)

b. Compare the classical management theories of F.W. Taylor and Henri Fayol with modern approaches like systems and contingency theory. (7 Marks)

MODULE 2

13a. Describe Herzberg’s Two-Factor Theory and Maslow’s Hierarchy of Needs. How can managers apply them to motivate employees? (7 Marks)

b. Explain the steps involved in manpower planning and differentiate between recruitment and selection with examples. (7 Marks)

OR

14a. You are leading a startup team facing internal disagreements. Explain how different types of negotiation and leadership styles can help resolve the conflict. (7 Marks)

b. Discuss the impact of communication barriers on leadership effectiveness and provide examples of how leaders can overcome them. (7 Marks)

MODULE 3

15a. Imagine you've identified a problem faced by college students — difficulty in finding affordable and quality food near campus. How would you use an Idea Canvas to shape a possible business solution? (7 Marks)

b. You are building a mobile app that alerts users about air quality levels in real time. Using an Empathy Canvas, explain how you would understand the daily experience of urban commuters who are your target users. (7 Marks)

OR

16a. A team of students has developed a low-cost, portable device to detect water leakage in household plumbing systems. Using the Value Proposition Canvas, explain how this solution fits the needs of middle-income homeowners. (7 Marks)

b. A startup team has developed a low-cost solar-powered drying solution to help small-scale agricultural producers reduce post-harvest losses. Using the Business Model Canvas, outline their customer segments, key partners, and value proposition. (7 Marks)

MODULE 4

17a. A product-based startup is working on modular housing solutions designed for quick deployment in disaster-hit regions. Describe how the team can develop a strong investor pitch focusing on revenue model, scalability, and social impact. (7 Marks)

b. A D2C (Direct-to-Consumer) skincare brand is looking to expand via digital platforms. Explain how influencer marketing and CRM tools can be integrated to build customer loyalty and drive conversions. (7 Marks)

OR

18a. A new mobile app startup wants to attract early investors. Explain the importance of understanding financial terms such as revenue, burn rate, and valuation when preparing for funding. Use simple examples to support your answer. (7 Marks)

b. A startup developing a wearable health monitoring device is preparing to pitch to early-stage investors. Outline the essential components that should be included in their pitch deck. (7 Marks)

MODULE 5

19a. A startup has created a catchy logo and app interface. Explain which types of IPR they need to protect and why each is important. (7 Marks)

b. You have developed a unique cooling technology for electric bikes. Describe the steps you would follow to file a patent in India and explain how it helps protect your innovation. (7 Marks)

OR

20a. Compare three common legal structures available for startups in India. For a tech-based service startup, which would you recommend and why? (7 Marks)

b. What are the key tax benefits offered under the Startup India Scheme and Section 80-IAC? How do these help early-stage startups survive financially? (7 Marks)

B24ME2L02	MATERIAL TESTING LAB	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	2	2024

Preamble

This course provides a thorough understanding of materials used in mechanical engineering, emphasizing structure-property relationships and their applications. Through lab experiments, students explore mechanical properties like tensile strength, shear strength, bending, and torsion, while measuring key properties such as Young's Modulus, yield strength, and ultimate tensile strength. They will also learn to calculate stress, strain, and displacement and apply these concepts to real-world structural design and analysis.

Overall, the Strength of Materials Lab develops essential technical skills, promotes safety awareness, ensures measurement accuracy, and encourages critical thinking—preparing students for effective engineering design and analysis.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Evaluate the strength of materials subjected to shear and bending forces. (Cognitive Knowledge Level: Apply)
CO 2	Verify the Clerk Maxwell's law of reciprocal and to determine the Young's Modulus of Material. (Cognitive Knowledge Level: Apply)
CO 3	Develop skills in presenting experimental findings with appropriate graphs, tables, and technical reports data in a structured and scientifically acceptable format. (Cognitive Knowledge Level: Analyse)
CO 4	Identify and specify suitable material for applications in the field of design and manufacturing. (Cognitive Knowledge Level: Apply)
CO 5	To evaluate the toughness of the given material using the Izod and Charpy impact testing machines. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3	1	1	2	2			3	2	1	2
CO 2	3	3	2		1	1		1	3	2	1	1
CO 3	3	3	2		2	2			3	3	1	1
CO 4	2	2	1	1					2	2	1	2
CO 5	2	2	1						2	2	1	2

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Class work/ Assessment Viva-voce : 20 marks
Viva voce / test : 15 marks
Record : 5 marks

End Semester Examination Pattern

Experiment part : 70 marks
Viva voce : 30 marks

Guidelines for award of marks for the experiment part:

Preliminary work : 15 Marks
Implementing the work/Conducting the experiment : 25 Marks
Performance, result and inference : 30 Marks

KNOWLEDGE IS POWER

SYLLABUS

LIST OF EXPERIMENTS

(Minimum **eight** experiments are mandatory)

1	To conduct tension test on ductile material (mild steel/ tor-steel/ high strength steel) using Universal tension testing machine and Extensometer.
2	To conduct shear test on mild steel rod.
3	To conduct Hardness test of a given material. (Brinell, Vickers and Rockwell)
4	To determine torsional rigidity of mild steel/copper/brass rod.
5	To determine flexural rigidity of mild steel/ copper/brass material using universal testing machine.
6	To conduct a Toughness test of the given material using Izod and Charpy Machine.
7	To determine spring stiffness of close coiled/open coiled/series/parallel arrangements
8	To conduct bending test on wooden beam
9	To conduct strain measurements using strain gauges
10	To conduct an experiment to Verify Clerk Maxwell's law of reciprocal deflection and determine young's Modulus of steel.
Activity: Students may be encouraged to visit different CNC facilities	

Reference Books

1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013
2. Dally J W, Railey W P, Experimental Stress analysis, McGarw Hill,1991 S Timoshenko, D H Young, et al, "Engineering mechanics", McGraw Hill Education.
3. Timoshenko, S., & Young, D. (2021). Strength of Materials. (3rd edition).
4. Russell Hibbeler, "Engineering mechanics: Statics and Dynamics", Pearson Education.

B24ME2L03	MACHINE TOOLS LAB	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	2	2024

Preamble

The Machine Tools Lab provides hands-on exposure to various machine tools and machining processes. It aims to develop proficiency in operating lathe, drilling, milling, grinding and welding equipment while understanding their operational principles. The lab emphasizes analyzing machining parameters like cutting force, power consumption, and surface finish, enhancing skills in manufacturing techniques, and exploring metallurgical processes such as heat treatment and testing. It bridges theoretical knowledge with practical applications, preparing students to tackle real-world machining challenges effectively.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply knowledge of machine tool operations to produce precision components with the desired quality. (Cognitive Knowledge Level: Apply)
CO 2	Analyze cutting mechanics to evaluate power consumption and optimize machining parameters for various operations. (Cognitive Knowledge Level: Analyze)
CO 3	Develop and select appropriate machining processes and parameters tailored for different materials. (Cognitive Knowledge Level: Analyze)
CO 4	Identify welded joints and inspect their quality for discontinuities and defects using standard evaluation techniques. (Cognitive Knowledge Level: Apply)
CO 5	Identify the effects of heat treatment processes on metallurgical properties and interpret the results for practical applications. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3		1		1			2		
CO 2	3	3	2	3	2							
CO 3	2	3	3	3	3							
CO 4	2	1	2			3			3	2	2	1
CO 5	3	2	1	2	2							3

Assessment Pattern

Bloom's Category	Continuous Assessment (%Marks)	End Semester Examination (%Marks)
Remember	10	
Understand	20	20
Apply	40	50
Analyze	30	30
Evaluate		
Create		

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Class work/ Assessment /Viva-voce : 20 marks
Test /Viva voce : 15 marks
Record : 5 marks

End Semester Examination Pattern

Experiment Part : 70 marks
Viva voce : 30 marks

Guidelines for award of marks for the experiment part:

Preliminary work : 5 Marks
Dimensions and Overall Finish : 60 Marks
Overall Finish : 5 Marks

KNOWLEDGE IS POWER

SYLLABUS

LIST OF EXPERIMENTS

Part A: Machining Experiments (Minimum 8 required)	
1	**Study and exercises on conventional lathe**: Plain turning, step turning, taper turning, ball and curve making, and thread cutting.
2	**Exercises on Engine Lathe**: Measurement of cutting forces using a lathe tool dynamometer.
3	**Exercises on shaping machine**: Flat surfaces, grooves, and keyways.
4	**Exercises on slotting machine**: Flat surfaces, grooves, keyways, curved surfaces, boring, and spur gear making.
5	**Exercises on radial drilling machine**: Drilling, boring, reaming, tapping, and countersinking.
6	**Exercises on radial drilling machine**: Measurement of cutting forces using a drill dynamometer.
7	**Study and exercises on cylindrical grinding machine, surface grinding machine, and universal tool & cutter grinding machine**.
8	**Study and exercises on universal milling machines**: Plane and pocket milling, slab milling, keyways, and spur gear making
9	**Exercises on milling machine**: Measurement of cutting forces in the milling process.
10	**Exercises on normal arc welding, GTAW, and GMAW**: Butt welding and lap welding of mild steel sheets.
11	**Exercises on gas welding**: Butt welding and lap welding of mild steel sheets.
Part B: Advanced Machining and Metallurgy Studies (Minimum 2 required)	
12	**Preparation and microscopic examination of ferrous and non-ferrous material samples**: Specimen preparation, etching, and grain size analysis.
13	**Heat treatment experiments**: Effects of annealing, normalizing, hardening, and tempering on steel. Hardness testing and microstructural analysis under different conditions.
14	**Study and demonstration of modern cutting machines**: Water jet cutting. Abrasive water jet cutting. Laser beam machining.

Reference Books

1. Acherkan N. S., "Machine Tool Vol. I-IV," MIR Publications.
2. HMT, "Production Technology," Tata McGraw Hill Education.
3. W. A. J. Chapman, "Workshop Technology Part I," ELBS & Edward Arnold Publishers.
4. S. K. Hajra Choudhury, A. K. Hajra Choudhury, et al., "Elements of Workshop Technology Vol. I & II," Media Promoters and Publishers Pvt. Ltd.

<table>
<tr><td rowspan="2">B24MC2T04</td><td rowspan="2">UNIVERSAL HUMAN VALUES AND CONSTITUTIONAL RIGHTS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td><td>P/F</td><td>2024</td></tr>
</table>

Preamble: This course explores various dimensions of human existence, beginning with self-awareness and an understanding of essential needs such as prosperity, happiness, inner peace, and harmonious relationships. It also introduces the preamble and key features of the Indian Constitution, along with the Directive Principles of State Policy, highlighting their importance in shaping governance and promoting social welfare. By the end of the course, students will be better equipped to act responsibly, address challenges with sustainable solutions, and foster positive human relationships grounded in an understanding of human nature.

Prerequisite:

Nil

Course Outcomes:

After the completion of the course, the student will be able to

CO1	Understand the importance of value education for holistic development and to fulfill human aspirations. (Cognitive Knowledge Level: Understand)
CO2	Develop more awareness of themselves, and their surroundings (family, society, nature) to build harmonious and respectful relationships. (Cognitive Knowledge Level: Apply)
CO3	Understand and appreciate the preamble and other features in the Indian Constitution to promote responsible citizenship. (Cognitive Knowledge Level: Understand)
CO4	Understand the fundamental rights and duties enshrined in the Indian Constitution and the Directive Principles of State Policy and their role in shaping governance and social welfare. (Cognitive Knowledge Level: Understand)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						2	1	2	1	1	1	2
CO 2						2	2	2	2	1	1	2
CO 3						2	2	2		2		2
CO 4						2	2	2		2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests Test ((%))	End Semester Examination ((%))
Remember	30	30
Understand	60	60
Apply	10	10
Analyze		
Evaluate		
Create		

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	50	50	2 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (1 number)
(conducted for 50 marks and reduced to 25) : 25 marks
Project/ Seminar : 15 marks

End Semester Examination Pattern:

There will be two parts, Part A and Part B. Part A contains 4 questions carrying 3 marks from each module. Part B contains 2 questions from each module out of which one is to be answered. In Part B, each question of first two modules carries 9 marks and each question of last two modules carries 10 marks.

SYLLABUS

MODULE 1 (6 hours)

Introduction to Values

The Need of Value Education-Guidelines for Value Education, Self-exploration as the Process for Value Education-Two parts, Important implications of Self Exploration, Continuous Happiness and Prosperity -A Look at Basic Human Aspirations-Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)- Method to fulfill the Basic Human Aspirations.

MODULE 2 (5 hours)

Harmony in the Human Being, Family and Society

Understanding Human being as the Co-existence of the Self and the Body-Distinguishing between the Needs of the Self and the Body-Harmony of the Self with the Body- Harmony in the Family – the Basic Unit of Human Interaction- Understanding Harmony in the Society.

MODULE 3 (5 hours)

Introduction to Constitution of India

Definition and Historical Background of the Constitution-Salient Features of the Constitution-Preamble of the Constitution-Union and Its Territory- Meaning and Types of Citizenship-Termination of Citizenship.

MODULE 4 (8 hours)

State Policies and Fundamental Rights

Definition of the State-Fundamental Rights- General Nature and Classification-Right to Equality and Right to Freedom-Right Against Exploitation- Right to Freedom of Religion-Cultural and Educational Rights- Right to Constitutional Remedies- Protection Against Conviction for Offences-Right to Information (RTI) and Its Applications-Directive Principles of State Policy- Classification of Directives-Fundamental Duties.

Text Books

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 3rd Revised Edition, Excel Books, New Delhi, 2023.
2. The Teacher's Manual for a Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 3rd Revised Edition, Excel Books, New Delhi, 2023.
3. D D Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi, 26/e, 2022
4. P M Bhakshi, The constitution of India, Universal Law, 19/e, 2023

Reference Books

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi,2006.
3. Ministry of Law and Justice, The constitution of India, Govt of India, New Delhi,2019.
4. J N Pandey, The constitutional Law of India, Central Law Agency, Allahabad, 51e,2019.
5. M V Pylee, Indias Constitution, S Chand and Company, New Delhi,16e, 2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lecture/ Tutorial hours
	Module 1	**6**
1.1	The Need of Value Education-Guidelines for Value Education	1
1.2	Self-exploration as the Process for Value Education-Two Parts	1
1.3	Important implications of Self Exploration	1
1.4	Continuous Happiness and Prosperity -A Look at Basic Human Aspirations	1
1.5	Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)	1
1.6	Method to fulfill the Basic Human Aspirations	1
	Module 2	**5**
2.1	Understanding Human being as the Co-existence of the Self and the Body	1
2.2	Distinguishing between the Needs of the Self and the Body	1
2.3	Harmony of the Self with the Body	1
2.4	Harmony in the Family – the Basic Unit of Human Interaction	1
2.5	Understanding Harmony in the Society	1
	Module 3	**5**
3.1	Definition and Historical Background of the Constitution	1
3.2	Salient Features of the Constitution	1
3.3	Preamble of the Constitution-Union and Its Territory	1
3.4	Meaning and Types of Citizenship	1
3.5	Termination of Citizenship.	1
	Module 4	**8**
4.1	Definition of the State- Fundamental Rights- General Nature and Classification	1
4.2	Right to Equality and Right to Freedom-Right Against Exploitation-Right to Freedom of Religion	1
4.3	Cultural and Educational Rights- Right to Constitutional Remedies	1
4.4	Protection Against Conviction for Offences	1
4.5	Right to Information (RTI) and Its Applications	1
4.6	Directive Principles of State Policy	1
4.7	Classification of Directives	1
4.8	Fundamental Duties	1
	Total	**24 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1)

1. Explain the basic guidelines for value education. What is the need for these guidelines.

2. Explain the process of self-exploration. What is the expected result of self-exploration?
3. What are the basic human aspirations and what are the requirements to fulfill them? Support your answer with two examples.

Course Outcome 2 (CO2)

1. Distinguish between ‘animal consciousness and ‘human consciousness.
2. ’Relationship is – between one Self (I1) and another Self (I2)’. Examine this statement.
3. What is the building block for harmony in the society? Explain with examples.

Course Outcome 3 (CO3)

1. Describe the historical background of the Indian Constitution.
2. Explain the salient features of the Indian constitution.
3. Summarize the importance of preamble in the implementation of constitution.

Course Outcome 4 (CO4)

1. What are fundamental rights? Examine each of them.
2. Examine the scope of freedom of speech and expression underlying the constitution.
3. Explain the concept of Union and its territory.
4. What is the Fee for seeking information from Central Government Public Authorities?
5. Explain the provision of appeal under the RTI Act.

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 1

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: B24MC2T04

Course Name: UNIVERSAL HUMAN VALUES AND CONSTITUTIONAL RIGHTS

Max.Marks:50 Duration: 2 hours

PARTA

Answer all questions. Each question carries 3 marks.

1. Identify the solution which helps human being to transform from animal Consciousness to human consciousness.
2. What is the building block for harmony in the society?
3. Define and explain the term Constitution.
4. “The freedom of speech and expression is subject to reasonable restrictions”. Explain the statement.

PART B

Answer any one question from each module.

Module 1

5. Explain the basic guidelines for value education. What is the need for these guidelines. (9 marks)

OR

6. Choose any five things that you consider as human values. Write all the basic guidelines, and check if they satisfy the basic guidelines. (9 marks)

Module 2

7. Distinguish between ‘animal consciousness and ‘human consciousness’ (9 marks)

OR

8. Relationship is – between one Self(I1) and another Self(I2). Examine this statement. (9 marks)

Module 3

9. Summarize the various methods of acquiring Indian citizenship. (10 Marks)

OR

10. Examine the salient features of the Indian constitution. (10 marks)

Module 4

11. Explain the meaning, significance and classification of the Directive Principles of State Policy. (10 marks)

OR

12. Explain the fundamental duties of an Indian Citizen. (10 marks)

B24MC2T05	ENERGY CONSERVATION AND ENVIRONMENTAL SUSTAINABILITY	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		2	0	0	2	P/F	2024

Preamble:
This course aims to equip students with fundamental knowledge of energy resources, the need for energy conservation, and the importance of environmental sustainability. It emphasizes the role of engineers in adopting renewable energy technologies, reducing environmental impact, and promoting sustainable development for a greener and more resilient future.

Prerequisite: NIL

Course Outcomes: After completion of the course the student will be able to

CO1	Classify various energy resources and describe the importance of energy conservation **(Cognitive Knowledge Level: Understand)**
CO2	Explain the principles of renewable energy systems and their applications **(Cognitive Knowledge Level: Understand)**
CO3	Recognize major environmental impacts due to energy consumption and explain basic pollution control measures. **(Cognitive Knowledge Level: Understand)**
CO4	Describe sustainability concepts and apply simple strategies for environmental protection and green practices in day-to-day engineering tasks **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					2	3	1		1		2
CO 2	2					2	3	1		1		2
CO 3	2					2	3	1		1		3
CO 4	2					3	3	1		1		3

Assessment Pattern

Bloom's Category	Continuous Assessment Test 1 (%Marks)	End Semester Examination (%Marks)
Remember	30	30
Understand	50	50
Apply	20	20
Analyse		
Evaluate		
Create		

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	50	50	2 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (1) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 4 questions carrying 3 marks each. Part B contains 2 questions from each module out of which one has to be answered. In part B, each question of the first two modules carries 9 marks and each question of the last two modules carries 10 marks.

SYLLABUS

Module 1: Energy Resources and Conservation (6 hours)

Types of Energy Resources: Renewable and Non-renewable (with examples), Global and Indian Energy Scenarios, Importance of Energy Conservation, Energy Policy and Planning.

Energy Auditing and Efficiency Improvement Techniques - Case studies, Energy-efficient Buildings and Smart Cities

Module 2: Renewable Energy Technologies (6 hours)

Solar Energy, Wind Energy, Other Renewable Sources: Biomass and bioenergy systems, small hydropower, ocean thermal, wave, and tidal energy, Geothermal energy

Energy Storage and Smart Grid Integration: Battery technologies - Role in renewable energy conservation and stability - Decentralized generation and net metering, Advanced and Emerging Technologies: Green hydrogen - Floating solar farms - Offshore wind.

Module 3: Environmental Impact and Pollution Control (6 hours)

Pollution Types and Sources: Air pollution: industrial emissions, vehicular sources - Water pollution: domestic, industrial, agricultural waste - Soil pollution: hazardous waste, agrochemicals, Pollution Control Methods: Physical, chemical, biological techniques - Air & water treatment technologies

Climate Change and Global Warming: Greenhouse gases and carbon footprint - International agreements, Waste Management Strategies - 3Rs (Reduce, Reuse, Recycle) - waste-to-energy, Environmental Regulations in India: Environmental Protection Act, Air & Water Acts - Hazardous Waste Management Rules, Carbon Neutrality and Zero-emission Policies

Module 4: Sustainability and Green Practices (6 hours)

Principles of Sustainable Development: Intergenerational equity, resource efficiency - Link with UN Sustainable Development Goals (SDGs), Green Buildings and Infrastructure, Green Certification Systems, Carbon Credits.

Carbon Pricing and Energy Subsidies: Internal carbon pricing by organizations - Government schemes, Life Cycle Assessment (LCA): Phases of LCA: Goal definition, inventory, impact assessment - Smart Sustainable Cities and Resilient Infrastructure: Urban planning for sustainability.

TEXTBOOKS AND REFERENCES

1. Charles M. Gottschalk, *Industrial Energy Conservation*, John Wiley & Sons, 1996.
2. G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers
3. R.R. Rao, *Environmental Science and Engineering*, PHI
4. Craig B. Smith, *Energy Management Principles*, Pergamon Press.
5. Paul O'Callaghan, *Energy Management*, McGraw Hill Book Co.

6. Wayne C. Turner, *Energy Management Hand Book*, The Fairmount Press, Inc., 1997.
7. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
8. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

COURSE CONTENT AND LECTURE SCHEDULE

No.	Topics	No. of Lecture hours/ tutorial hours
	Module 1	**6 hours**
1.1	Types of Energy Resources (Renewable and Non-renewable), examples. Global and Indian Energy Scenario: Consumption and production trends, sector-wise demand	1
1.2	Energy Conservation: Residential, Industrial, Transport sectors – behavioural & technological interventions	1
1.3	Energy Policy and Planning: National Energy Policy, Energy Conservation Act, BEE initiatives	1
1.4	Energy Auditing: Preliminary & Detailed audits, Performance Indicators, Case Studies	2
1.5	Energy-efficient Buildings & Smart Cities: Passive design, daylighting, automation	1
	Module 2	**6 hours**
2.1	Solar Energy: PV systems, solar thermal, rooftop/grid-tied applications	1
2.2	Wind Energy: Onshore/offshore systems, hybrid solar-wind systems	1
2.3	Other Renewables: Biomass, small hydro, ocean, tidal, geothermal energy	1
2.4	Energy Storage: Battery types, conservation role, stability, smart grid integration	1
2.5	Smart Grids and Net Metering: Decentralized generation	1
2.6	Advanced Technologies: Green hydrogen, floating solar farms, offshore wind	1
	Module 3	**6 hours**
3.1	Pollution Types: Air, water, and soil pollution – sources and effects	1
3.2	Pollution Control: Physical, chemical, and biological treatment methods	1
3.3	Climate Change: GHGs, carbon footprint, international agreements (Kyoto, Paris)	1
3.4	Waste Management: Solid, liquid, biomedical, hazardous – 3Rs, waste-to-energy, Environmental regulations	1
3.5	Carbon Neutrality: National missions, zero-emission policies, corporate initiatives,	1
3.6	Circular Economy: Waste elimination	1

	Module 4	6 hours
4.1	Sustainable Development: Principles, SDGs, resource efficiency	1
4.2	Green Buildings: Concepts, features, materials, passive design, renewables integration, green certifications	1
4.3	Carbon Credits: Earning, trading, CDM, voluntary carbon markets	1
4.4	Carbon Pricing and Subsidies: Internal pricing, UJALA, PM-KUSUM, FAME	1
4.5	Life Cycle Assessment (LCA): Phases, case studies	1
4.6	Smart Cities and Resilience: Urban planning	1
Students shall present a seminar based on case studies of Life Cycle Assessment (LCA) conducted on a product of their choice.		
	Total	**24 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. List the major renewable and non-renewable energy sources with suitable examples.
2. Explain the significance of energy conservation in the industrial and domestic sectors.
3. Describe the importance of energy conservation in the context of the global and Indian energy scenario.

Course Outcome 2 (CO2):

1. Describe the working principle of solar photovoltaic and solar thermal systems.
2. Compare wind energy and small hydropower systems based on availability, reliability, and applications.
3. Explain the role of energy storage and smart grid integration in ensuring renewable energy reliability.

Course Outcome 3 (CO3):

1. Identify major sources of air and water pollution in urban areas.
2. Explain the role of battery storage and smart grid integration in enhancing the efficiency of renewable energy systems
3. Apply the concept of 3Rs to develop a basic household or institutional waste management plan.

Course Outcome 4 (CO4):

1. Describe the concept of sustainable development and its connection with UN Sustainable Development Goals (SDGs).
2. Explain the basic features of green buildings and the benefits of green certification.
3. Describe simple green practices that can be adopted by engineers in daily professional work to promote environmental sustainability.

MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MC2T05**

Course Name: **ENERGY CONSERVATION AND ENVIRONMENTAL SUSTAINABILITY**

Max. Marks: 50 Duration: 2 hours

PART A

Answer all questions. Each question carries 3 marks.

1. List any three renewable energy sources with one example each.
2. Explain the concept of net metering in decentralized energy generation.
3. What are the major sources of air pollution in urban areas?
4. Describe any two strategies for promoting sustainability in everyday engineering practices.

PART B ***(Answer one full question from each module)***

MODULE 1

5. a) Classify energy resources with examples. (4 marks)
   b) Explain the significance of energy conservation in the Indian context. (5 marks)

OR

6. a) Describe energy auditing and mention any two efficiency improvement techniques. (5 marks)
   b) What is the role of energy-efficient buildings in smart city development? (4 marks)

MODULE 2

7. a) Explain the working principle of wind turbines with a neat diagram. (5 marks)
   b) Describe any two advanced renewable energy technologies. (4 marks)

OR

8. a) Discuss the types and role of energy storage systems in renewable energy. (5 marks)
   b) Explain the concept of smart grid integration. (4 marks)

MODULE 3

9. a) What are the major environmental impacts of energy consumption? (4 marks)
   b) Explain physical, chemical, and biological methods of water pollution control. (6 marks)

OR

10. a) Describe the working of waste-to-energy technologies. (5 marks)
    b) List and briefly explain any two environmental regulations in India. (5 marks)

MODULE 4

11. a) Define sustainable development and explain its principles. (4 marks)
    b) What are carbon credits and how do they promote sustainability? (6 marks)

OR

12. a) Explain the key phases of Life Cycle Assessment (LCA). (5 marks)
    b) What is the importance of green buildings and certification systems in achieving sustainable urban infrastructure? (5 marks)

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MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 3

(MINOR)

SYLLABUS

B24MEM31	MECHANICS OF MATERIALS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

The course aims to equip students with the knowledge of stress, strain, and their relationship, and to enable them to analyze and predict the mechanical behavior of materials in various practical scenarios. The course encompasses a broad spectrum of topics including axial loading, bending, torsion, strain energy, buckling, and failure theories, all of which are essential for the design of safe and efficient structural elements such as beams, columns, shafts, and machinery. By learning this course, students develop the ability to comprehend the internal forces within structures, anticipate their behaviour under different types of loading conditions, and make prudent decisions regarding material selection, design factors, and failure prevention. This course forms the foundation for multiple engineering disciplines, especially civil, mechanical, and aerospace engineering, and is critical for ensuring the safety, reliability, and durability of engineering systems and structures.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Identify the strength of materials using stress-strain relationships for structural and thermal loading. (Cognitive Knowledge Level: Apply)
CO 2	Apply tensorial and Mohr's circle approaches to evaluate stresses, strains, and displacements in structural systems. (Cognitive Knowledge Level: Apply)
CO 3	Develop basic design of shafts subjected to torsional loading and analyse stability of columns subjected to buckling. (Cognitive Knowledge Level: Apply)
CO 4	Construct shear force and bending moment diagrams for beams under flexural loads and determine deflection of beams. (Cognitive Knowledge Level: Apply)
CO 5	Apply theories of failure in structural design and solve simple problems using energy methods. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	1		1						1
CO 2	3	3	2	2		1						1
CO 3	3	3	1	2		1						1
CO 4	3	3	1	2		1						1
CO 5	3	3	1	2		1						1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (10 hours)

Introduction to mechanics of deformable bodies, method of sections. Concept of stress and strain. Mechanical properties of materials, stress -strain curve for ductile and brittle materials. Hooke's law, constants of elasticity: Young's modulus, Shear modulus, Bulk modulus and Poisson's ratio. Relations between elastic constants. Constitutive relations for linearly elastic and isotropic materials.

Determination of stress and strain in bars of uniform cross sections subjected to axial loading, axial rigidity.

Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.

MODULE 2 (10 hours)

Stress vectors on cartesian coordinate planes, stress tensor. Equality of cross shears. Cauchy's stress formula. Stress invariants, principal stresses and principal planes, maximum shear stress.

Analysis of strain, displacement field, strain tensor, strain compatibility equations.

Plane stress and plane strain conditions, Mohr's circle construction and problems for 2D case.

MODULE 3 (8 hours)

Introduction to torsion of circular shafts, assumptions in theory of pure torsion, derivation of torsional formula. Torsional rigidity and polar section modulus. Strength and rigidity based design of hollow and solid circular shafts.

Introduction to elastic stability and buckling of columns, modes of failure of columns. Euler's buckling theory for long columns, slenderness ratio, Rankine's theory for short columns.

MODULE 4 (9 hours)

Beams – Classification and types of loadings, flexural formula, section modulus, flexural rigidity.

Shear Force and Bending Moment Diagrams. Differential equations between load, shear force and bending moment. Normal and shear stress in beams shear stress distribution for a rectangular section.

Deflection of beams using Macauley's method, Differential equation for elastic curve.

MODULE 5 (8 hours)

Introduction to Theories of Failure, Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain, Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy.

Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads. Castigliano's second theorem, reciprocal relation, proof for Castigliano's second theorem. Simple problems to find the deflections using Castigliano's theorem.

Text Books

1. Mechanics of materials in S.I.units, R. C. Hibbeler, Pearson Higher Education 2018
2. Mechanics of Materials, F. Beer, E. R. Johnston, J. T. DeWolf, Tata McGraw Hill, 2020
3. Advanced Mechanics of Solids, L. S. Srinath, TMH
4. Strength of Materials, S.S.Rattan , McGraw Hill Education India, 2016

Reference Books

1. An introduction to the Mechanics of Solids, S. H. Crandal, N. C. Dhal, T. J. Lardner, McGraw Hill, 2008
2. Mechanics of Materials, James M. Gere, Stephen Timoshenko, CBS Publishers & Distributors, New Delhi,2012
3. Engineering Mechanics of Solids, E. P. Popov, Pearson Education, 2015
4. Mechanics of Materials, Pytel A. and Kiusalaas J. Cengage Learning India Private Limited, 2^{nd} Edition, 2015

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**10**
1.1	Introduction to mechanics of deformable bodies, method of sections.	2
1.2	Concept of stress and strain. Mechanical properties of materials, stress -strain curve for ductile and brittle materials. Hooke's law	2
1.3	Constants of elasticity: Young's modulus, Shear modulus, Bulk modulus and Poisson's ratio.	1
1.4	Relations between elastic constants. Constitutive relations for linearly elastic and isotropic materials.	1
1.5	Determination of stress and strain in bars of uniform cross sections subjected to axial loading, axial rigidity	2
1.6	Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.	2
	Module 2	**10**
2.1	Stress vectors on cartesian coordinate planes, stress tensor.	2
2.2	Equality of cross shears. Cauchy's stress formula.	1
2.3	Stress invariants	1
2.4	Principal stresses and principal planes, maximum shear stress.	1
2.5	Analysis of strain and displacement field	1
2.6	Strain tensor, strain compatibility equations. Plane stress and plane strain conditions	2
2.7	Mohr's circle construction and problems for 2D case.	2

	Module 3	**8**
3.1	Introduction to torsion of circular shafts, assumptions in theory of pure torsion, derivation of torsional formula.	1
3.2	Torsional rigidity and polar section modulus.	1
3.3	Strength and rigidity based design of hollow and solid circular shafts.	2
3.4	Introduction to elastic stability and buckling of columns	1
3.5	Modes of failure of columns. Euler's buckling theory for long columns	2
3.6	Slenderness ratio, Rankine's theory for short columns.	1
	Module 4	**9**
4.1	Beams – Classification and types of loadings, flexural formula, section modulus, flexural rigidity	2
4.2	Shear Force and Bending Moment Diagrams.	3
4.3	Differential equations between load, shear force and bending moment. Normal and shear stress in beams shear stress distribution for a rectangular section.	2
4.4	Deflection of beams using Macauley's method, Differential equation for elastic curve.	2
	Module 5	**8**
5.1	Introduction to Theories of Failure, Rankine's theory for maximum normal stress	1
5.2	Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain	1
5.3	Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy.	1
5.4	Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads.	2
5.5	Castigliano's second theorem, reciprocal relation	1
5.6	Proof for Castigliano's second theorem. Simple problems to find the deflections using Castigliano's theorem.	2
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Write the generalized Hooke's law for stress-strain relations.
2. Estimate the state of strain from a given state of stress.
3. Analyse the strength of a structure subjected to thermal loading.

Course Outcome 2 (CO2):

1. Determine the resultant traction at a point in a plane using the stress tensor.
2. Evaluate the principal stresses, principal strains and their directions from a given state of stress or strain.
3. Write the stress tensor and strain tensor.

Course Outcome 3 (CO3):

1. Design a shaft to transmit power and torque.
2. Compare strength of solid and hollow shafts.
3. Analyze a column for buckling load.

Course Outcome 4 (CO4):

1. Draw the shear force and bending moment diagrams.
2. Determine the bending stress on a beam subjected to pure bending.
3. Determine deflection of beams using Macauley's method.

Course Outcome 5 (CO5):

1. A bolt is subjected to a direct tensile load of 20 kN and a shear load of 15 kN. Suggest suitable size of this bolt according to various theories of elastic failure, if the yield stress in simple tension is 360 MPa. A factor of safety 2 should be used. Assume Poisson's ratio as 0.3.
2. Apply strain energy method to estimate the deformation of a structure.
3. Use strain energy method to estimate the loads acting on a structure for a maximum deflection.

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEM31**

Course Name: **MECHANICS OF MATERIALS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1) Explain Hooke's law for linearly elastic isotropic material.
2) Write down the general expression for temperature stress and explain the terms in it.
3) What are stress invariants? Why do they remain invariant?
4) Distinguish between plane stress and plane strain conditions by citing examples for each case.
5) Define Flexural rigidity. What is its importance?
6) Define slenderness ratio. Explain the limitations of Euler's formula for long columns.
7) Draw the S.F and B.M. diagrams for a simply supported beam of length L carrying a clockwise couple of 'M' Nm at the midsection of the beam.
8) Explain the significance of flexural rigidity and section modulus in the analysis of beams.
9) Explain Rankine's theory of failure.
10) Explain Castigliano's second theorem

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11) A steel rod of 20 mm diameter is enclosed in a copper tube of 40 mm external diameter and 25 mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. If the assembly is subjected to an axial load of 50 kN, find the stress developed in each material. Take the elastic modulus of copper and steel as 1.2 x10^5 N/mm^2 and 2 x10^5 N/mm^2. (14 marks)

.

OR

12) A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar and the tube. Given: $E_s = 2 \times 10^5$ N/mm^2, $E_b = 1 \times 10^5$ N/mm^2 $\alpha s = 11.6 \times 10^{-6}$/°C and $\alpha b = 18.7 \times 10^{-6}$/°C. (14 marks)

Module 2

13) Determine the stress invariants, principal stresses and principal directions from the stress matrix at a point on a submarine hull given as follows: (14 marks)

$$\begin{bmatrix} 8 & 0 & 6 \\ 0 & 5 & 0 \\ 6 & 0 & -8 \end{bmatrix} \text{MPa}$$

OR

14) At a point in a bracket the stresses on two mutually perpendicular planes are 140 N/mm^2 and 70 N/mm^2 both tensile. The shear stress across these planes is 30 N/mm^2. Using the Mohr's stress circle determine the

i. principal stresses
ii. maximum shear stress
iii. principal planes and
iv. plane of maximum shear stress. (14 marks)

Module 3

15) a) What are the assumptions taken while deriving Torsion equation (4 marks)

b) A solid aluminum shaft 1.5 m long and 60 mm diameter is to be replaced by a tubular steel shaft of the same length and the same outside diameter such that each of the two shafts could have the same angle of twist per unit torsional moment over the total length. What must the inner diameter of the tubular steel shaft be? Modulus of rigidity of the steel is three times that of aluminium. (10 marks)

OR

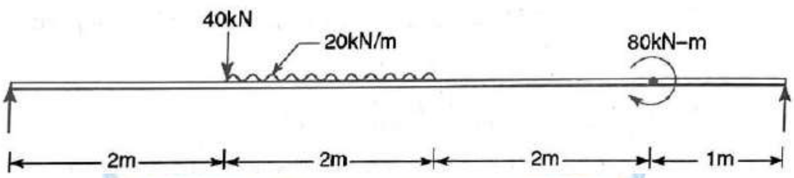
16) A 1.5 m long column has a circular cross section of 5 cm diameter. One of the ends of the column is fixed in direction and position and other end is free. Taking factor of safety as 3, calculate the safe load using

(i) Rankine's formula, take yield stress as 560 N/mm^2 and $\alpha = 1/1600$ for pinned ends and

(ii) Euler's Formula, Take $E = 1.2 \times 10^5$ N/mm^2. (14 marks)

Module 4

17) Draw the shear force and bending moment diagrams for the simply supported beam shown in the figure. Calculate and locate the position of maximum bending moment. (14 marks)



OR

18) A simply supported beam of 8 m length carries two point loads of 64 kN and 48 kN at 1 m and 4 m, respectively, from the left-hand end. Find the deflection under each load and the maximum deflection using Macauley's method. Take E = 210 GPa and I = 180 × 10^6 mm^4. (14 marks)

Module 5

19) Determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN. Using

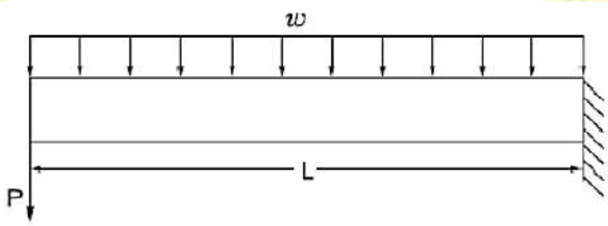
a. Maximum shear stress theory
b. Maximum strain energy theory
c. Maximum shear strain energy theory

Yield stress corresponding to elastic limit is 225 MPa,
Factor of Safety = 3, and Poisson's ratio = 0.3 (14 marks)

OR

20) a) Derive the expression for strain energy due to bending. (4 marks)

b) The cantilever beam supports a uniformly distributed load w and a concentrated load P as shown in figure. Also, it is given that L= 2 m, w = 4 kN/m, P = 6 kN and EI = 5 MNm^2. Determine the deflection at the free end using Castigliano's theorem. (10 marks)



B24MEM32	FLUID MECHANICS AND MACHINERY	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course covers the fundamental principles of fluid mechanics and hydraulic machinery. Topics include fluid properties, fluid statics, and dynamics, including Bernoulli's and Euler's equations. The course also explores boundary layer concepts, closed conduit flow, and the measurement of flow using various devices. Additionally, the design and application of hydraulic turbines and pumps are discussed, including their performance characteristics and selection criteria. By the end of this course, students will have a comprehensive understanding of fluid mechanics and its practical applications in hydraulic machinery.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to

CO 1	Explain the characteristics of fluids and solve hydrostatic problems. (Cognitive knowledge level: Understand)
CO 2	Outline different approaches to fluid kinematics and classify fluid flows. (Cognitive knowledge level Understand)
CO 3	Apply Euler equation and Bernoulli’s equation to the fluid flow problems. (Cognitive knowledge level: Apply)
CO 4	Make use of geometric similarity and unit-specific quantities to design and select suitable hydraulic turbines for specific hydro-power plant application. (Cognitive knowledge level: Apply)
CO 5	Utilize the principles of pump operation to design, select, and evaluate the suitability of centrifugal and reciprocating pumps. (Cognitive knowledge level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1						1			1
CO 2	3	2	1	1					1			1
CO 3	3	3	1	2					1			1
CO 4	3	3	2	1					1			1
CO 5	3	2	1	2					1			1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	40	10	10
Understand	60	30	30
Apply		60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (9 hours)

Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, measurement of pressure – Piezometer, U tube and differential manometers

MODULE 2 (9 hours)

Eulerian and Lagrangian approaches, Stream line, path line and streak lines and stream tube, velocity and acceleration in fluid. classification of flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows-equation of continuity for one dimensional flow. Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend. Navier-Stokes Equation Introduction only.

MODULE 3 (9 hours)

Boundary Layer Concept: Definition, thickness, characteristics along thin plate, laminar and turbulent boundary layers (No derivation). Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Major and Minor losses – pipes in series and pipes in parallel- total energy line-hydraulic gradient line. Measurement of flow: Pitot tube, Venturi meter and Orifice meter

MODULE 4 (9 hours)

Classification of turbines, design of Pelton wheel, Francis turbine and Kaplan turbine–working proportion, work done, efficiency, draft tube-theory, functions and efficiency. Geometric similarity, Unit and specific quantities,
characteristic curves, selection of type of turbine, cavitation, surge tank and water hammer, elements of hydro power plant.

MODULE 5 (9 hours)

Classification, centrifugal pumps–types, working, work done, monomeric head, losses and efficiency, specific speed – pumps in series and parallel – performance characteristic curves, NPSH, Reciprocating Pump – types, Working, Discharge, slip, indicator diagrams. Air vessels and its purpose

Text Books

1. Hydraulics and Fluid mechanics including Hydraulic Machines, Modi and Seth, 21st
2. Introduction to Fluid Mechanics, R. W. Fox, A. T. McDonald, 2001.
3. Subramanya K. Fluid Mechanics & Hydraulic Machines. Tata McGraw-Hill Education; 2001.
4. Bansal RK. Fluid mechanics and hydraulic machines. 2011.

Reference Books

1. White, F. M., Fluid Mechanics, McGraw Hill Education India Private Limited, 8th Edition, 2017
2. Rathakrishnan, E. Fluid Mechanics: An Introduction, Prentice Hall India, 3rd Edition 2012.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module 1	**9**
1.1	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure.	3
1.2	Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids.	3
1.3	Fluid Statics- Pressure-density-height relationship, measurement of pressure – Piezometer, U tube and differential manometers.	3
	Module 2	**9**
2.1	Kinematics of fluid flow: Eulerian and Lagrangian approaches.	3
2.2	Stream line, path line and streak lines and stream tube, velocity and acceleration in fluid.classification of flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows	3
2.3	Continuity equation for one dimensional flow Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend. Navier-Stokes Equation Introduction only.	3
	Module 3	**9**
3.1	Boundary Layer Concept: Definition, thickness, characteristics along thin plate, laminar and turbulent boundary layers (No derivation)	3
3.2	Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Major and Minor losses – pipes in series and pipes in parallel-total energy line-hydraulic gradient line	3
3.3	Dynamics of Fluid flow: Bernoulli's equation. Measurement of flow: Pitot tube, Venturi meter and Orifice meter	3
	Module 4	**9**
4.1	Classification of turbines, design of Pelton wheel, Francis turbine and Kaplan turbine–working proportion, work done, efficiency, draft tube-theory, functions and efficiency	3
4.2	Geometric similarity, Unit and specific quantities, characteristic curves, selection of type of turbines	3
4.3	Cavitation, surge tank and water hammer, elements of hydro power plant	3
	Module 5	**9**
5.1	Classification, centrifugal pumps–types, working, work done, monomeric head, losses and efficiency.	3
5.2	specific speed – pumps in series and parallel – performance characteristic curves, NPSH	3
5.3	Reciprocating Pump – types, Working, Discharge, slip, indicator diagrams. Air vessels and its purpose.	3
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. A cylinder 0.12m radius rotates concentrically inside a fixed cylinder of 0.13 m radius. Both cylinders are 0.3m long. Determine the viscosity of liquid which fills the space between the cylinders, if A torque of 0.88 Nm is required to maintain an angular velocity of 2 π rad / sec.

2. A stationary liquid is stratified so that its density is $\rho 0(1+h)$ at a depth h below the free surface. At a depth h in this liquid, what is the pressure in excess of $\rho 0gh$?

3. If the velocity profile of a fluid is parabolic with free stream velocity 120 cm/s occurring at 20 cm from the plate, calculate the velocity gradients and shear stress at a distance of 0, 10, 20 cm from the plate. Take the viscosity of fluid as 8.5 poise.

Course Outcome 2 (CO2):

1. Differentiate between Eulerian and Lagrangian method of representing fluid motion.

2. A velocity field is given by $u=3y^2$, $v=2x$ and $w = 0$ in arbitrary units. Is this flow steady or unsteady?
   Is it two or three dimensional? At (x, y, z) = (2,1,0), compute

   a. velocity
   b. local acceleration
   c. convective acceleration

3. What is Euler's equation of motion? How will you obtain Bernoulli's equation from it?

Course Outcome 3 (CO3):

1. Two reservoirs are connected by a pipe line consisting of two pipes, one of 15cm diameter and length 6m and the other diameter 22.5cm and 16m length. If the difference of water levels in the two reservoirs is 6m. Calculate the discharge and draw the energy gradient line. Take f=0.004

2. Derive the Euler's equation of motion along a streamline and from that derive the Bernoulli's equation.

3. What is Venturi meter? Derive the expression for Coefficient of discharge for Venturi meter

Course Outcome 4 (CO4):

1. A Pelton wheel has a mean bucket speed of 10m/s with a jet of water flowing at the rate of 700 Litre/sec under a head of 30 m. the buckets deflect the jet through an angle of 1600 calculate the power given by the water to the runner and hydraulic efficiency of the turbine? Assume co-efficient of velocity=0.98.

2. Prove that the force exerted by a jet of water on a fixed semi-circular plate in the direction of the jet when the jet strikes at the centre of the semi-circular plate is two times the force exerted by the jet on an fixed vertical plate.

3. (a) What are the unit quantities used to analyse the performance of hydraulic turbines. Explain its importance.
   (b) What is specific speed of a turbine.

Course Outcome 5 (CO5)

1. A centrifugal pump discharges 0.15 m^3/s of water against a head of 12.5 m, the speed of the impeller being 600 r.p.m. The outer and inner diameters of impeller are 500 mm and 250 mm respectively and the vanes are bent back at 35° to the tangent at exit. If the area of flow remains 0.07 m^2 from inlet to outlet, calculate.

   (a) Manometric efficiency of pump,
   (b) Vane angle at inlet, and
   (c) Loss of head at inlet to impeller when discharge is reduced by 40% without changing the speed.

2. (a) What is slip in a reciprocating pump. What is the reason for negative slip in a reciprocating pump.

   (b) A single acting reciprocating pump having a bore of 150 mm and a stroke of 300 mm length, discharges 250 l of water per minute at 50 rpm. Neglecting losses, find theoretical discharge and slip of the pump.

   (c) With a neat sketch explain the working of a gear pump. Explain the importance of dimensionless numbers and discuss any two similarity laws. Where are these model laws used?

3. Explain the following terms as they are applied to a centrifugal pump:

   (a) Static suction lift,

   (b) static suction head,

   (c) static discharge head and

   (d) total static head.

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEM32**

Course Name: **FLUID MECHANICS AND MACHINERY**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. The specific gravity of a liquid is 3.0. What are its specific weight, specific mass, specific volume.
2. State Pascal's law and give some examples where this principle is used.
3. Explain Streamlines, Streak lines and Path lines.
4. Define and distinguish between steady flow and uniform flow. Give two examples of each flow
5. Define the following terms (i) Total Energy line (ii) Hydraulic Gradient line
6. 6. Differentiate between pitot tube and pitot static tube.
7. What is degree of reaction? What will be the degree of reaction for a Pelton wheel.
8. Explain speed ratio and jet ratio.
9. Define slip, percentage slip and negative slip of a reciprocating pump.
10. What is the purpose of air vessels in multi-cylinder reciprocating pump.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11.a) The space between two parallel square plates each of side 0.8m is filled with an oil of specific gravity 0.8. If the space between the plates is 12.5mm and the upper plate which moves with velocity of 1.25m/s requires a force of 51.2 N. Determine (i) Dynamic viscosity of oil in poise (ii) Kinematic viscosity in stokes. (7 marks)

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b) A U- tube mercury manometer is used to measure the pressure of oil flowing through a pipe whose specific gravity is 0.85. The center of the pipe is 15 cm below the level of mercury. The mercury level difference in the manometer is 25 cm, determine the absolute pressure of the oil flowing through the pipe. Atmospheric pressure is 750 mm of Hg. (7 marks)

OR

12.a) Two large planes are parallel to each other and are inclined at 30° to the horizontal with the space between them filled with a fluid of viscosity 20 cp. A small thin plate of 0.125 m square slides parallel and midway between the planes and reaches a constant velocity of 2 m/s. (7 marks)

b) A spherical water drop of 1 mm diameter splits up in air into 64 smaller drops of equal size. Find the work required in splitting up the drop. The surface tension coefficient of water in air = 0.073 *N/m.* (7 marks)

Module 2

13.a) What is Euler's equation of motion? How to obtain Bernoulli's equation from it? (10 marks)

b) Explain the assumptions of Bernoulli's Equation. (4 marks)

OR

14.a) The velocity vector in a fluid flow is given by $v=4x^3i-10x^2y^2j+2tk$ find the velocity and acceleration of a fluid particle at (2,1,3) at time t=1 (10 marks)

b) Explain Rotational flow and Irrotational flow. (4 marks)

Module 3

15.a) A submarine moves horizontally in sea and has its axis 15 m below the surface of the water. A pitot tube properly placed just in front of the submarine and along its axis is connected to two limbs of a U tube containing mercury. The difference of level is found to be 170 mm. Find the speed of the submarine knowing that the specific gravity of mercury is 13.6 and that of sea water is 1.026 with respect to water. (7 marks)

b) A pitot tube is inserted in a pipe of 30 cm diameter. The static pressure of the tube is 10 cm of mercury vacuum. The stagnation pressure at the centre of the pipe recorded by the pitot tube is 1.0 $N=cm^2$. Calculate the rate of flow of water through the pipe, if the mean velocity of flow is 0.85 times central velocity. Assume coefficient of tube as 0.98. (7 marks)

OR

16.a) Derive Hagen-Poiseuille equation from the fundamentals and state the assumptions made (7 marks)

b) Petrol of specific gravity 0.8 is following through a pipe of 30 cm diameter. The pipe is inclined at 30° to horizontal. The venturi has a throat diameter of 10 cm. U tube manometer reads 6.25 cm Hg. Calculate the discharge through the pipe. Assume Cd = 0.98. (7 marks)

Module 4

17.a) A Francis turbine with an overall efficiency of 75% is required to produce 148.25kW power. It is working under a head of 7.62m. The peripheral velocity=$0.26\sqrt{2gh}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gh}$. The wheel runs at 150rpm and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge determine

i. The guide blade angle.

ii. The wheel vane angle at inlet

iii. The diameter of the wheel at inlet, and

iv) Width of the wheel at inlet (8 marks)

b). Explain the theory of Draft Tube. (6 marks)

OR

18. a) A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 litres/s under a head of 30 m. The buckets deflect the jet through an angle of 160°. Calculate the power given by the water to the runner and the hydraulic efficiency of the turbine. Assume coefficient of velocity as 0.98. (7 Marks)

b) A Kaplan turbine runner is to be designed to develop 7357.5 kW shaft power. The net available head is 10 m. Assume that the speed ratio is 1.8 and flow ratio is 0.6. If the overall efficiency is 70% and diameter of the boss is 0.4 times the diameter of the runner, find the diameter of the runner, its speed and specific speed. (7 Marks)

Module 5

19. a) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm works under total head of 32m. The velocity of flow through the impeller is constant and equal to 3m/sec. The vanes are set back at an angle of 30° at the outlet. If the outer diameter of the impeller is 600mm and width at outlet is 50mm, determine (i) vane angle at inlet (ii) work done per sec by the impeller (iii) manometric efficiency. (7 marks)

b) Derive an expression for the minimum starting speed of a centrifugal pump (7 marks)

OR

20.a) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. Find the expression for work done per second in the case of single acting reciprocating pump. (7 marks)

b) A double acting reciprocating pump, having cylinder diameter 15 cm and stroke length 30 cm is used raise the water through a height of 30 meters. If the pump is working at 30rpm and the pump efficiency is 73%o, what power is required to drive the pump? (7 marks)

B24MEM33	MATERIAL SCIENCE & TECHNOLOGY	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course will help the student understand the relationship between chemical bonds and the crystal structures of metallic materials. It will enable them to recognize the significance of crystal imperfections, such as dislocations, in plastic deformation. The course will also guide the student in examining the mechanisms of material failure through fatigue and creep. Additionally, it will provide them with a solid grasp of the fundamental characteristics, properties, and applications of various engineering materials.

Prerequisite

NIL

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Interpret the atomic bonding & crystal structures which reveals their relationship with the properties. (Cognitive Knowledge Level: Understand)
CO 2	Explain the fundamental principles of strengthening mechanisms in metallurgy. (Cognitive Knowledge Level: Understand)
CO 3	Identify the factors that influence fatigue failures like material properties, stress concentrations, environmental conditions and loading conditions. (Cognitive Knowledge Level: Apply)
CO 4	Understand the different types of engineering materials used for industrial and daily life applications. (Cognitive Knowledge Level: Understand)
CO 5	Outline the general properties of engineering materials that are important for design and applications. (Cognitive Knowledge Level: Understand)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	1									
CO 2	2	2	1	1						1		1
CO 3	2	2	2				1					
CO 4	2	2	2	1	2				1			2
CO 5	1	2	2	1		1				1		

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	40	20	20
Understand	60	60	60
Apply		20	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

KNOWLEDGE IS POWER

SYLLABUS

MODULE 1 (8 hours)

Introduction to material science - Fundamental concept of atomic structure – Atomic Bonding in solids, Classifications of Engineering Materials, Crystallography - SC, BCC, FCC, HCP structures, APF - theoretical density - property relationships in materials

MODULE 2 (9 hours)

Miller Indices: - crystal plane and direction, Crystal imperfections – Classifications and examples, Diffusion in solids, fick's laws - Applications of diffusion - dislocation density, mechanism of crystallization: homogeneous and heterogeneous nuclei formation, Hall - Petch theory.

MODULE 3 (8 hours)

Strengthening mechanisms- Overview of Strengthening Mechanisms, Types of Strengthening Mechanisms, Fracture:- Introduction to Fracture, Types of fracture - brittle and ductile fracture - DBTT, Fatigue - Stress cycles, S-N Curve, fatigue tests, Factors Affecting Fatigue Life, Creep- Creep curves, creep tests, Applications and Challenges

MODULE 4 (10 hours)

Composites – Introduction of composites, Need of development of composites - fiber and matrix phase - polymer matrix composites - metal matrix composites - ceramic matrix composites, Engineering Materials:- Ferrous and Non Ferrous materials, Plastic:- types, Properties and its applications

MODULE 5 (10 hours)

Mechanical Properties - Overview of mechanical properties and their significance in materials including Elastic and Plastic deformation, Tensile, Hardness, Machinability, formability and weldability.
Electrical Properties - Introduction to the fundamental concepts, exploring charge carriers, conductivity, resistivity, and the role of energy band structures in materials, classification of electrical properties, including conductors, semiconductors and insulators.
Corrosion and Degradation of Materials - Introduction to the fundamental concepts of corrosion, including its definition, significance, and economic and safety implications in various industries, corrosion rate, different types of corrosion.

Text Books

1. Callister William. D, Material Science and Engineering, John Wiley, 2014
2. Raghavan V, Material Science and Engineering, Prentice Hall, 2004

Reference Books

1. Introduction to Engineering Materials, B. K. Agrawal, Tata McGraw Hill Education Private Limited
2. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill, 1976
3. Anderson J.C. *et.al*., Material Science for Engineers, Chapman and Hall, 1990

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**8**
1.1	Introduction to Material Science and Science - Atomic structure and bonding –Ionic, covalent and Metallic bonding, its properties - correlation of atomic radius to strength; electron configurations	2
1.2	Secondary bonds – van der walls bonding, Classifications of Engineering Materials – Specific heat, applications	2
1.3	Crystallography – Crystal, Space lattice, Unit cells:- SC, BCC, FCC and HCP unit cells, Calculation of number of atoms per unit cell and its relation to density	2
1.4	Coordination Number - Atomic Packing Factor - theoretical density – Simple problems, Polymorphism and allotropy.	2
	Module 2	**9**
2.1	Miller indices: - crystal plane and direction	2
2.2	Modes of plastic deformation- Slip and twinning	1
2.3	Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC	1
2.4	Classification of crystal imperfections;- 0-D, 1-D and 2-D and 3D defects	2
2.5	Diffusion in solids, fick's laws, mechanisms, applications - dislocation density	1
2.5	Mechanism of crystallization, Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity. Hall – Petch theory	2
	Module 3	**8**
3.1	Strengthening mechanisms:- Overview of Strengthening Mechanisms, Types of Strengthening Mechanisms-solid-solution strengthening, precipitation, grain refinement and work hardening	2
3.2	Fracture:-Types of fracture - brittle and ductile fracture - DBTT	1
3.3	Fatigue: - Stress cycles – Primary and secondary stress raisers	2
3.4	Characteristics of fatigue failure, fatigue tests, S-N curve attributes.	1
3.5	Factors Affecting Fatigue Life	1
3.5	Creep: - Creep curves, creep tests, Applications and Challenges	1
	Module 4	**10**
4.1	Composites: - Need of development of composites; fiber phase; matrix phase; only need and characteristics of PMC, MMC, and CMC.	2
4.2	Modern engineering materials: - Ferrous materials - Steels, Plain carbon steel, Alloy Steel, Maraging steels, Stainless steels, Tool steels, Cast iron (only fundamentals)	2
4.3	Non-ferrous materials: Aluminium alloys, Copper alloys, Magnesium alloys, Titanium alloys, super alloys (only fundamentals)	2
4.4	Plastics – Introduction to plastic, Chemistry of plastic.	2

	Types of plastic - Thermosetting and thermoplastic materials, Properties and applications	2
	Module 5	**10**
5.1	Overview of different properties of engineering materials and its importance, Classifications	1
5.2	Mechanical Properties of Materials- Elastic deformation, Plastic deformation, Tensile strength and Hardness, Machinability, formability and weldability	2
5.3	Electrical Properties of Materials: Introduction to the fundamental concepts, role of energy band structures in materials	1
5.4	Exploring charge carriers Resistivity, conductivity, Semiconductors, Dielectric, Ferroelectric and Piezoelectricity	2
5.5	Corrosion and Degradation of Materials – Definition, Factors affecting corrosion and degradation, Corrosion rate	2
5.6	Types of corrosion – Crevice Corrosion, Stress Corrosion, Intergranular Corrosion, Galvanic Corrosion, Pitting Corrosion, Uniform Corrosion	2
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Which are the characteristics of ionic crystal
2. What is co-ordination Number
3. Define Fick's First law of diffusion
4. Explain why covalently bonded materials are generally less dense than ionically or metallically bonded ones

Course Outcome 2 (CO2):

1. What is the driving force for recrystallisation and grain growth of metallic crystals
2. Define Hall-Petch theory
3. What are the roles of surface defects on crack propagation

Course Outcome 3 (CO3):

1. Compare interstitial and vacancy mechanisms for diffusion.
2. Explain the effect of impact loading on ductile materials
3. Explain the factors affecting the fatigue strength

Course Outcome 4 (CO4):

1. Define Composites? How they are classified?
2. List three functions of the matrix phase in a polymer-matrix fiber-reinforced composite.
3. Explain the importance of all the non-ferrous alloys in automotive applications.

Course Outcome 5 (CO5):

1. What is the difference between normal stress and shear stress?
2. How does temperature affect the conductivity of metals and semiconductors?
3. What is the role of grain size in determining the strength of a material?

MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name : ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

THIRD SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEM33**

Course Name: **MATERIAL SCIENCE AND TECHNOLOGY**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Which are the characteristics of ionic crystal?
2. What are the lattice parameters that define a unit cell? List them.
3. What is co-ordination Number?
4. What is Hall-Petch Theory.
5. Compare interstitial and vacancy mechanisms for diffusion.
6. Discuss two basic modes of plastic deformation.
7. What is the main difference between plain carbon steel and alloy steel?
8. Define Composites? How they are classified?
9. What is corrosion, and why does it occur?
10. What is superconductivity, and how is it different from perfect conductivity?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) Explain Bohr's model and Rutherford's atomic model. (6)

 b) Describe about secondary bonds. (8)

OR

12. Prove that FCC is closely packed than BCC by calculating atomic packing factor of both. (14)

Module 2

13. a) What are crystallographic planes? How Miller indices for planes can be determined? (6)

b) Explain about the types of surface defects (8)

OR

14. a) Brief about slip and twinning. (6)

b) Distinguish between homogeneous and heterogeneous nuclei formation. (8)

Module 3

15. a) How do ductile and brittle fractures differ from each other? (8)

b) Discuss the importance of ductile to brittle transition temperature. (6)

OR

16. a) What are the different regions in the creep curve? Explain each region. (7)

b) With the help of a simple sketch, explain fatigue test. (7)

Module 4

17. a) Explain fibre reinforced composites (7)

b) What is polymer matrix composite? Explain its types. (7)

OR

18. a) Explain ceramic matrix composite. Mention any two applications. (7)

b) Explain the classification of ferrous materials and their key properties. (7)

Module 5

19. a) What is hardness, and how is it measured? Compare the applications of materials with varying hardness levels. (8)

b) What is superconductivity? Describe its key characteristics. (6)

OR

20. a) What are the challenges in developing materials with both high strength and excellent electrical conductivity? (8)

b) What is the significance of the modulus of elasticity (Young’s modulus) in engineering? Explain its role in material selection (6)

KNOWLEDGE IS POWER

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 4

SYLLABUS

SEMESTER 4

SLOT	COURSE NO.	COURSES	L-T-P-S	HOURS	CREDIT
A	B24MA2T04B	STATISTICAL ANALYSIS AND NUMERICAL METHODS	3-1-0-3	4	4
B	B24ME2T04	THEORY OF MACHINES	3-1-0-3	4	4
C	B24ME2T05	METROLOGY AND MACHINE TOOLS	3-1-0-3	4	3
D	B24ME2T06	ENGINEERING THERMODYNAMICS	3-1-0-3	4	4
E	B24HU2T01	BUSINESS ECONOMICS AND FINANCIAL MANAGEMENT	3-0-0-3	3	3
F	B24ME2T07	FLUID MACHINES	2-1-0-2	3	3
G	B24ME2L04	MECHANICAL MEASUREMENTS LAB	0-0-3-3	3	2
H	B24ME2L05	FLUID MECHANICS AND MACHINES LAB	0-0-3-3	3	2
M	B24MEM4x	MINOR	3-1-0-3	4	4
N	B24MEH4x	HONORS	3-1-0-3	4	4
			TOTAL*	**36**	**25**

* Semester total does not include the credits of honors and minor courses

MINOR COURSES

BASKET	COURSE NO.	COURSE NAME
BASKET I (DESIGN)	B24MEM41	MECHANICS OF MACHINES
BASKET II (THERMAL)	B24MEM42	THERMODYNAMICS
BASKET III (PRODUCTION)	B24MEM43	MANUFACTURING PROCESS

HONOURS COURSES

GROUP	COURSE NO.	COURSE NAME
GROUP I (DESIGN)	B24MEH41	DESIGN OF HYDRAULIC AND PNEUMATIC EQUIPMENTS
GROUP II (THERMAL)	B24MEH42	ADVANCED FLUID MECHANICS
GROUP III (PRODUCTION)	B24MEH43	ADVANCED ENGINEERING MATERIALS

B24MA2T04B	STATISTICAL ANALYSIS AND NUMERICAL METHODS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble:

This course aims to introduce students to the modern theory of probability and statistics covering important models of discrete and continuous random variables. It also covers techniques of parameter estimation and hypothesis testing. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

Prerequisites: Nil

Course Outcomes:

After the completion of the course the student will be able to:

CO 1	Utilize the concept, properties and important models of discrete random variables and, using them, solve suitable random phenomena. (Cognitive Knowledge Level: Apply)
CO 2	Utilize the concept, properties and important models of continuous random variables and, using them, solve suitable random phenomena.(Cognitive Knowledge Level: Apply)
CO 3	Develop statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population (Cognitive Knowledge Level: Apply)
CO 4	Evaluate roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques (Cognitive Knowledge Level: Apply)
CO 5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes With Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	2	2					2		1
CO 2	3	2	2	2	2					2		1
CO 3	3	2	2	2	2					2		1
CO 4	3	2	2	2	2					2		1
CO 5	3	2	2	2	2					2		1

Assessment Pattern

Bloom's Category	**Continuous Assessment**		**End Semester Examination (% Marks)**
	Test 1 (% Marks)	**Test 2 (% Marks)**	
Remember	30	30	30
Understand	40	40	40
Apply	30	30	30
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance	10 marks
Continuous Assessment Test (2 numbers)	25 marks
Assignment/Quiz/Course Project	15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

MODULE 1: Discrete probability distributions(9 hours)

(Text 1: Relevant topics from sections 3.1-3.4, 3.6, 5.1)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution,Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation -multiple random variables

MODULE:2 Continuous probability distributions (9 hours)

(Text 1 : Relevant topics from sections 4.1-4.4, 3.6,5.1)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential , normal distributions , Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation-multiple random variables, i.i.d random variables and Central limit theorem (without proof)

MODULE 3 :Testing of Hypothesis (9 hours)

(Text 1 : Relevant topics from sections 3.6, 5.1, 5.4,7.2, 8.1, 8.3, 9.1,9.2,9.4)

Population and samples, Sampling distribution of the mean and proportion, Confidence interval for single mean and single proportions. Test of hypotheses: Large sample test for single mean and single proportion, equality of means and equality of proportions of two populations, small sample t-tests for single mean of normal population, equality of means.

MODULE: 4 Numerical methods -I(9 hours)

(Text 2 : Relevant topics from sections 19.1, 19.2, 19.3, 19.5)

Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method . Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)

MODULE: 5 Numerical methods -II(9 hours)

(Text 2 : Relevant topics from sections 20.3, 20.5, 21.1)

Solution of linear systems-Gauss-Seidel and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order(Proof or derivation of the formulae not required for any of the methods in this module)

Text Books

1. (Text-1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8^{th} edition, Cengage, 2012
2. (Text-2) Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, John Wiley Sons, 2016. .

Reference Books

1. Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2. Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
3. T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No of Lecture/Tutorial Hours
1	**Module 1: Discrete Probability distributions**	**9**
1.1	Discrete Probability distributions	3
1.2	Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial	3
1.3	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	3
2	**Module 2: Continuous Probability distributions**	**9**
2.1	Continuous random variables and probability distributions, expected value, mean and variance .	2
2.2	Uniform, exponential and normal distributions, mean and variance of these distributions	4

2.3	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	3
3	**Module 3: Testing of Hypothesis**	**9**
3.1	Population and samples, Sampling distribution of single mean and single proportion	1
3.2	Confidence interval for single mean and single proportions	2
3.3	Hypothesis testing basics, large sample test for single proportion, single proportion	2
3.4	Large sample test for equality of means and equality of proportions of two populations	2
3.5	t-distribution and small sample t-test for single mean and pooled t test for equality of means	2
4	**Module 4: Numerical methods-I**	**9**
4.1	Roots of equations- Newton-Raphson	2
4.2	Interpolation-finite differences, Newton's forward and backward formula	3
4.3	Newton's divided difference method, Lagrange's method .	2
4.4	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	2
5	**Module 5: Numerical methods-II**	**9**
5.1	Solution of linear systems-Gauss-Siedal method, Jacobi iteration .	2
5.2	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares.	2
5.3	Solution of ODE-Euler and Classical Runge-Kutta methods of second and fourth order .	5
	Total	**45 Hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO 1):Understand the concept, properties and important models of discrete random variables and, using them, analyse suitable random phenomena. .

1. The probability that a batsman scores a century in a cricket match is $\frac{1}{3}$. Find the probability that out of 5 matches, he may score century in (i) at least 2 matches (ii) at most 2 matches (iii) no match.

2. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X, Y)

3. Of all customers purchasing automatic garage-door openers, 75% purchase a chain-driven model. Let X the number among the next 15 purchasers who select the chain-driven model.

(a) What is the pmf of X?

(b) If the store currently has in stock 10 chain-driven models and 8 shaft-driven models, what is the probability that the requests of these 15 customers can all be met from existing stock?

Course Outcome 2 (CO 2): Understand the concept, properties and important models of continuous random variables and, using them, analyse suitable random phenomena

1. A random variable has a normal distribution with standard deviation 10. If the probability that it will take on a value less than 82.5 is 0.82, what is the probability that it will take on a value more than 58.3?
2. Assume that the time between arrivals of customers at a particular bank is exponentially distributed with a mean of 4 minutes
   (a) Find the probability that the time between arrivals is greater than 5 minutes.
   (b) Find the probability that the time between arrivals is between 1 and 4 minutes.
3. Verify whether X and Y are independent if $f(x, y) = 24xy, 0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq x + y \leq 1$.

Course Outcome 3 (CO 3): Analyse stochastic processes using autocorrelation, power spectrum and understand multivariable probability distribution.

1. In a random sample of 500 people selected from the population of a city 60 were found to be left-handed. Find a 95% confidence interval for the proportion of lefthanded people in the city population.
2. A magazine reported the results of a telephone poll of 800 adult citizens of a country. The question posed was: "Should the tax on cigarettes be raised to pay for health care reform?" The results of the survey were: Out of the 800 persons surveyed, 605 were non-smokers out of which 351 answered "yes" and the rest "no". Out of the remaining 195, who were smokers, 41 answered "yes" and the remaining "no". Is there sufficient evidence, at the 0.05 significance level, to conclude that the two populations smokers and non-smokers differ significantly with respect to their opinions?
3. A sample of 20 items has mean 42 and SD 5. Test whether the sample is from a population with mean 45? (5 % level of significance)

Course Outcome 4 (CO 4): Compute roots of equations, evaluate definite integrals and perform interpola- tion on given numerical data using standard numerical techniques.

1. Use Newton-Raphson method find correct to 4 decimals places, the root between 0 and 1 of the equation $x^3 - 6x + 4 = 0$.

2. A river is 80m wide. The depth y in meters at a distance x meters from one bank is given by the following table. Find approximately the area of cross section.

X	0	10	20	30	40	50	60	70	80
Y	0	5	8	10	15	12	7	3	1

3. Using Lagrange's interpolation formula, fit a polynomial to the given data

X	1	2	7	8
Y	4	5	5	4

Course Outcome 5 (CO 5):Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.

1. Solve the equations using Gauss Seidal method

   $x + 2y + z = 3$
   $2x + 3y + 2z = 5$
   $3x - 5y + 5z = 2$
   $3x + 9y - z = 4$

2. Obtain the value of y at $x = 0.2$ using Runge- Kutta method of fourth order for the differential equation $\frac{dy}{dx} = 1 + y^2$ with $h = 0.2$, $y(0) = 0$.

3. Write the normal equations for fitting the curve $y = a + bx$.

MODEL QUESTION PAPER

QP CODE: **Pages: 2**

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2025

Course Code: B24MA2T04B

Course Name: STATISTICAL ANALYSIS AND NUMERICAL METHODS

Max. Marks: 100 Duration: 3 hours

PART A
Answer all questions. Each question carries 3 marks.

1. Determine the binomial distribution for which mean is 4 and variance is 3.
2. Suppose $E(X) = 5$ and $E[X(X-1)] = 25$. Find $E(X^2)$.
3. Derive the mean and variance of exponential distribution.
4. Life time of a particular variety of bulbs is a random variable with mean 1200 hrs and S.D. 250 hrs. Use Central Limit Theorem to find the probability that average life time of 60 bulbs exceeds 1250 hrs
5. For the population of individuals who own iPhone, $p = 0.25$ is the proportion that has a given app. For a random sample of size $n = 4$, find mean and standard deviation of the sampling distribution of the population proportion
6. If the mean age of 64 men engaged in an occupation is 52.4 years with S.D 10.2 years, construct 90% confidence limit for the mean age of all men in that occupation.
7. Use trapezoidal rule to evaluate $\int_0^1 x^3$considering five subintervals.
8. Write the formula for finding $\sqrt{5}$ using Newton-Raphson's Method.
9. Using Euler's method, find $y(0.2)$ if $y' = x + y$, $y(0) = 1$.
10. Obtain the values of y in $x = 0.1$ using the Runge- Kutta method of second order for the differential equation$y' = -y, y(0) = 1$

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. (a) A car hire firm has 2 cars which it hires out day by day. The number of demands for a car on each day is distributed as a Poisson distribution with mean 2. Calculate the proportion of days on which (i) neither car is used (ii) some demand is refused. 7

(b) Suppose that 20% of all copies of a particular textbook fail a certain binding strength test. Let X denote the number among 15 randomly chosen copies that fail the test. Using the table of Binomial distributions or by direct calculation. 1) Find the probability that at most 8 will fail the test. 2) Find the probability that exactly 8 will fail the test. 3) Find the probability that at least 8 will fail the test. 4) Find the probability that failure is between 4 and 7 (inclusive). 7

OR

12. (a) A Random variable X has the following probability distribution function.

X	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Y	a	$3a$	$5a$	$7a$	$9a$	$11a$	$13a$	$15a$	$17a$

Determine (i) the value of a (ii) $P(\text{X}\leq 3)$ (iii) $P(\text{X}\geq 3)$(iv) $P(4 \leq\text{X}\leq 7)$ 7

(b) The joint probability mass function of X and Y is given by $p(x, y) = (x + 2y) \div 18$ if $(x, y) = (1, 1), (1, 2), (2, 1), (2, 2)$. Find (i) Marginal distributions (ii) Verify whether X and Y are independent.

7

Module 2

13. (a) The weight of certain brand of shampoo packets are uniformly distributed between 9.3 gm and 10.5 gm. In a random lot of 100 packets how many packets (i) exceed 10 gm (ii) are below 10.2 gm. 7

(b) In a normal distribution 7% of the items are under 35 and 10% of the items are above 55. Calculate the mean and variance. 7

OR

14. (a) The time in hours required to repair a machine is exponentially distributed with mean 20. What is the probability that the required time (i) exceeds 30 hours? (ii) between 16 hours and 24 hours? 7

(b) .The joint PDF of continuous random variable X and Y is given by

$$f(x, y) = \begin{cases} kxy, 0 \leq x \leq 4, 1 \leq y \leq 5 \\ 0, otherwise \end{cases}$$

Find (i) the value of k (ii) $P(X > 3, Y < 4$ (iii) marginal distributions (iv) Check whether X and Y are independent. 7

Module 3

15. (a) A die is thrown 9000 times and 3220 times shown 5 or 6. Is the die unbiased at 5% level of significance? 7

(b) A random sample of size 6 has mean 25 and variance 3.83. Can the sample be regarded as taken from a population with mean lesser than 29 at 1% level of significance?. 7

OR

16. (a) The mean weight obtained from a random sample of size 100 is 64 gm. The standard deviation of the weight distribution of the population is 3 gm. Test the statement that the mean weight of the population is 67 gm at 5% level of significance 7

(b) The average marks scored by 50 students of class A is 42.75 with variance 1.98. The average marks scored by 60 students of class B is 42.15 with variance 1.82. Based on this data can we conclude that students of class A perform better than students of class B at at 5% level of significance level?

7

Module 4

17. (a) Use Lagrange's interpolation formula to find $y(2)$ from the following table

X	1	3	4
Y	1	27	64

7

(b) Find the positive root of the equation $x^3 + x + 1 = 0$ using Newton-Raphson method correct to 4 decimal places. 7

OR

18. (a) Evaluate $\int_0^2 xe^x dx$ using Simpson's $\frac{1}{3}$rd rule with $n = 8$. 7

(b) Compute $y(13)$ using Newton's Backward difference formula, if given

X	3	6	9	12	15
Y	18	27	36	45	54

7

Module 5

19. (a) Solve by Gauss-Seidel method the following system :

$28x + 4y - z = 32$
$x + 3y + 10z = 24$
$2x + 17y + 4z = 35$

7

(b) Fit a straight line to the points (0,2), (2,0), (3, -2) , (5, -3) using method of least squares. 7

OR

20. (a) Apply Gauss-Seidel method to solve the equations $20x + y - 2z = 17$
$3x + 20y - z = -18$
$2x - 3y + 20z = 25$. 7

(b) Solve using Runge - Kutta method of order 4: $y' = 8.5 - 20x + 12x^2 - 2x^3$, $y(0) = 1$ for $x = .5$ [Choose $h = .5$] . 7

<table>
<tr><td rowspan="2">B24ME2T04</td><td rowspan="2">THEORY OF MACHINES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>3</td><td>4</td><td>2024</td></tr>
</table>

Preamble

This course provides an in-depth study of kinematic principles, emphasizing the analysis of motion in mechanical systems, including displacement, velocity, and acceleration. It covers the operational theory of cams, gears, gear trains, and mechanism synthesis. Additionally, advanced topics such as static force analysis of planar mechanisms, gyroscopic effect dynamics, and the assessment and correction of unbalance in rotating and reciprocating systems are included to prepare students to tackle complex mechanical challenges effectively.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply kinematic principles to evaluate various mechanisms and perform displacement and velocity analysis. (Cognitive Knowledge Level: Apply)
CO 2	Apply graphical and analytical methods to calculate acceleration of different mechanisms and synthesize cam profiles for different motion types. (Cognitive Knowledge Level: Apply)
CO 3	Understand the gear terminology, tooth profiles and apply different techniques to synthesize four bar mechanism. (Cognitive Knowledge Level: Apply)
CO 4	Apply static force analysis techniques to different mechanisms and evaluate the effects of gyroscopic couples. (Cognitive Knowledge Level: Apply)
CO 5	Apply different methods to determine the unbalance in rotating and reciprocating masses. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	1									2
CO 2	3	2	3									2
CO 3	3	2	2		2							2
CO 4	3	2	1	2								2
CO 5	3	2	3	2	2							2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (9 hours)

Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves, mechanical advantage, transmission angle. Straight line generation mechanisms – exact & approximate. Velocity analysis of planar mechanisms Instantaneous centre -Kennedy's theorem – relative velocity method.

MODULE 2 (9 hours)

Acceleration analysis- Relative acceleration - Coriolis acceleration - graphical and analytical methods.

Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration. Graphical cam profile synthesis.

MODULE 3 (10 hours)

Gears – Classification- terminology of spur gears – law of gearing -tooth profiles- involute spur gears- contact ratio - interference - backlash - gear standardization –interchangeability. Gear trains - simple and compound gear trains - planetary gear trains.

Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis - precision points – Freudenstein's equation – path and prescribed timing. Graphical synthesis for motion -– Synthesis of 4 bar mechanisms

Computer Aided Synthesis of mechanisms.

MODULE 4 (8 hours)

Static force analysis- Analysis of four bar linkages and slider crank mechanism, graphical method, Matrix method, principle of virtual work. Analysis of four bar and slider crank mechanisms with sliding and pin friction.

Gyroscopic couples-spin, precession and applied gyroscopic couple vectors-effects on the stability of two wheelers, four wheelers, sea vessels and air crafts, application of gyroscopes

MODULE 5 (9 hours)

Static balancing-dynamic balancing-balancing of several masses in the same plane-several masses in different planes-graphical and analytical method-force and couple polygons.

Balancing of reciprocating masses -Single cylinder engine-multi cylinder engine -V-engine.

Simulation and Analysis of mechanisms using software.

Text Books

1. S. S. Rattan, "Theory of Machines'', Tata Mc Graw Hill, 2019.
2. Ballaney P. L., ''Theory of Machines and Mechanisms'', Khanna Publishers, 2018.

Reference Books

1. C. E. Wilson, P. Sadler, ‘’Kinematics and Dynamics of Machinery’’, Pearson Education,2014.
2. D. H. Myskza, ‘’Machines and Mechanisms Applied Kinematic Analysis’’, Pearson Education, 2015.
3. G. Erdman, G. N. Sandor, ‘’Mechanism Design: Analysis and synthesis’’, Vol I & II, Prentice Hall of India, 2001.
4. Ghosh, A. K. Malik, ‘’Theory of Mechanisms and Machines’’, Affiliated East West Press, 2015.
5. J. E. Shigley, J. J. Uicker, ‘’Theory of Machines and Mechanisms’’, McGraw Hill, 2023.
6. Norton, ‘’Kinematics and Dynamics of Machinery’’, Tata McGraw Hill, 2009.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**9**
1.1	Introduction to kinematics and mechanisms- various mechanisms.	2
1.2	Kinematic diagrams, degree of freedom- Grashof’s criterion.	2
1.3	Inversions.	1
1.4	Coupler curves, mechanical advantage, transmission angle.	1
1.5	Straight line mechanisms exact, approximate.	1
1.6	Velocity analysis- Instantaneous centre -Kennedy’s theorem- Relative velocity	2
	Module 2	**9**
2.1	Acceleration analysis- Relative acceleration, Coriolis acceleration.	1
2.2	Graphical and analytical methods.	2
2.3	Cams - classification of cam and followers.	1
2.4	Displacement diagrams, velocity and acceleration analysis of SHM.	2
2.5	Uniform velocity, uniform acceleration.	1
2.6	Graphical cam profile synthesis.	2
	Module 3	**10**
3.1	Gears – Classification- terminology of spur gears – law of gearing	1
3.2	Tooth profiles- involute spur gears- contact ratio - interference - backlash - gear standardization –interchangeability	1
3.3	Gear trains - simple and compound gear trains - planetary gear trains.	2
3.4	Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis.	2
3.5	Precision points – Freudenstein's equation -path and prescribed timing.	1

3.6	Graphical synthesis for motion –– Synthesis of 4 bar mechanisms	2
3.7	Computer Aided Synthesis of mechanisms.	1
	Module 4	**8**
4.1	Static force analysis- Analysis of four bar linkages and slider crank mechanism.	2
4.2	Graphical method, Matrix method.	1
4.3	principle of virtual work	1
4.4	Analysis of four bar and slider crank mechanisms with sliding and pin friction.	1
4.5	Gyroscopic couples-spin, precession and applied gyroscopic couple vectors.	2
4.6	Effects on the stability of, Four wheelers, two wheelers- sea vessels and air crafts	1
	Module 5	**9**
5.1	Static balancing-dynamic balancing	2
5.2	Balancing of several masses in the same plane	1
5.3	Several masses in different planes-graphical andmanalytical method	1
5.4	Force and couple polygons	1
5.5	Balancing of reciprocating masses -Single cylinder engine	1
5.6	Multi cylinder engine-v engine-inline engine	2
5.7	Simulation and Analysis of mechanisms using ADAMS software.	1
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. What are the different types of mechanism?
2. Explain the inversions of a four-bar mechanism.
3. What is Grashof's criterion and how it determines the degree of freedom of a mechanism?
4. Explain different classifications of straight-line mechanism.

Course Outcome 2 (CO2):

1. How is relative acceleration analyzed in mechanisms?
2. What is the significance of Coriolis acceleration in the motion of linkages, and how is it analyzed?
3. What are the different types of cams and followers?
4. How can displacement diagrams be used in the analysis of cam motions?

Course Outcome 3 (CO3):

1. What are the different classifications of gears?
2. With a neat sketch explain the terminology of spur gears.
3. What is Freudenstein's equation, and how is it used in the dimensional synthesis of mechanisms?
4. Explain the significance of path and prescribed timing in the synthesis of planar mechanisms.

Course Outcome 4 (CO4):

1. Perform the static force analysis of a slider-crank mechanism under various loading conditions.
2. Explain the principle of virtual work.
3. Explain gyroscopic effect.
4. How does the precession of a gyroscope affect the motion of a vehicle or aircraft?

Course Outcome 5 (CO5):

1. What is the difference between static and dynamic balancing?
2. Determine the magnitude and location of the balancing masses needed to balance the unbalanced masses rotating in different planes.
3. How can reciprocating masses be balanced in a single-cylinder engine?
4. How is dynamic balancing achieved in multi-cylinder and V-engine configurations?

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, JUNE 2025

***Course Code:* B24ME2T04**

***Course Name:* THEORY OF MACHINES**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. What do you mean by degree of freedom? How is it determined?
2. Explain Kennedy's theorem related to the instantaneous centres.
3. How do you find the magnitude and direction of Coriolis component of acceleration?
4. Obtain an expression for maximum velocity when a cam follower motion is in simple harmonic.
5. What do you mean by interference in gears?
6. Write three advantages of involute gear tooth profile over cycloid profile.
7. Explain the principal of virtual work.
8. How does gyroscope help in the guidance of ships?
9. Differentiate between static balancing and dynamic balancing.
10. What do you mean by primary and secondary unbalance in reciprocating engines?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. For a four-bar mechanism ABCD with the following dimensions, calculate the velocity of joint C and the angular velocities of links CD and BC, if the angular velocity of link AB is 10 rad/sec in the clockwise direction. The dimensions are: AB = 30 cm, BC = CD = 35 cm, AD (fixed) = 60 cm, and angle BAD = 60. Solve using the graphical method. (14 marks)

OR

12. a) With a neat sketch explain various inversions of a single slider crank chain. (8 marks)

b) With the help of a 4-bar mechanism of suitable dimensions of your choice, show the 3 types of instantaneous centres. (6 marks)

Module 2

13. For a slider-crank mechanism, the crank length is 200 mm, and the connecting rod length is 600 mm. The angular velocity of the crank is 50 rad/sec (clockwise), and the angular acceleration is 800 rad/sec² (clockwise). The crank angle is 1.20° from the inner dead center. Find the angular velocity and angular acceleration of the connecting rod. (14 marks)

OR

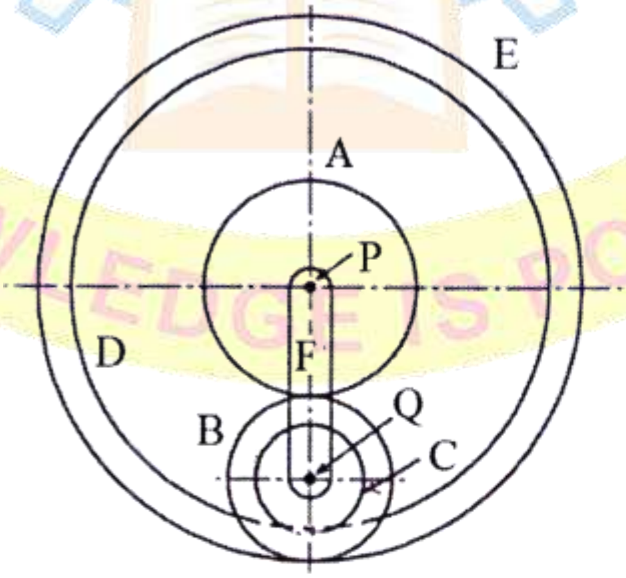
14. A disc cam profile is to be synthesized to provide simple harmonic motion (SHM) to a knife-edge offset follower during the outstroke of 50 mm. The cam's motion consists of the following: an ascent angle of 120°, dwell for 60°, a descent angle of 90°, and the follower dwells for the remaining cam rotation. The minimum radius of the cam is 50 mm. (14 marks)

a) Draw the cam profile when the knife-edge follower is offset by 20 mm.

b) Calculate the maximum velocity and acceleration during ascent and descent when the camshaft revolves at 240 rpm, and plot the velocity and acceleration diagrams.

Module 3

15. In a compound epicyclic gear train, as shown in the diagram, gears A, D, and E rotate freely on the axis P. The compound gears B and C rotate together on axis Q at the end of arm F. All gears have equal module, and the number of teeth on gears A, B, and C are 18, 45, and 21, respectively. Gears D and E are annular gears. Gear A rotates at 120 rpm counter-clockwise, and gear D rotates at 450 rpm clockwise. Determine the speed and direction of the arm F and gear E.



(14 marks)

16. a) What is Freudenstein's equation, and how can it be used to synthesize a four-bar mechanism to coordinate the input and output angles? Explain the process.

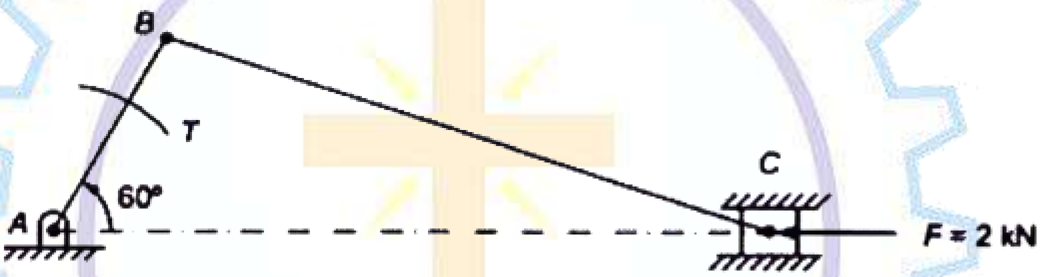
(8 marks)

b) Synthesize a slider-crank mechanism with an eccentricity of 9 mm for two input positions of the input link. $\Theta_{12} = 60^0$ and output slider displacement is 16 mm.

(6 marks)

Module 4

17. In the slider-crank mechanism shown in figure, where the force applied to the slider is 2 kN, and the link dimensions are as follows: AB = 80 mm, BC = 240 mm, and the crank angle θ=60∘. Determine the forces acting on the various links and the driving torque T.



(14 marks)

OR

18. An airplane flying at 240 km/h turns left and completes a quarter cycle with a radius of 60 m. The mass of the engine and propeller is 450 kg, with a radius of gyration of 320 mm. The engine speed is 2000 rpm in the clockwise direction when viewed from the rear. Calculate the gyroscopic couple acting on the aircraft.

(14 marks)

Module 5

19. Four masses m1, m2, m3, and m4 have values of 200 kg, 300 kg, 240 kg, and 260 kg, respectively. The corresponding radii of rotation are 0.2 m, 0.5 m, 0.25 m, and 0.3 m, respectively, with the angles between successive masses being 45°, 75°, and 135°. Determine the position and magnitude of the balancing mass required, assuming its radius of rotation is 0.2 m. (14 marks)

OR

20. An inside-cylinder locomotive has its cylinder centerlines 0.7 m apart and a stroke of 0.6 m. The rotating mass per cylinder is equivalent to 150 kg at the crank pin, and the reciprocating mass per cylinder is 180 kg. The wheel centerlines are 1.5 m apart, and the cranks are at right angles. The entire rotating and half of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Calculate the fluctuation in rail pressure under one wheel, the variation of tractive effort, and the magnitude of the swaying couple at a crank speed of 300 rpm. (14 marks)

B24ME2T05	METROLOGY AND MACHINE TOOLS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course provides a comprehensive understanding of machining fundamentals and precision measurement, emphasizing the operation of machine tools and advanced metrology techniques. It equips students with essential skills in manufacturing optimization, quality assurance, and process control. By integrating theoretical knowledge with practical applications, the course prepares students to analyze, measure, and enhance manufacturing processes, ensuring compliance with industry standards and improving overall production efficiency.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply the principles of machining operations, including cutting forces, chip formation, and tool geometry. (Cognitive Knowledge Level: Apply)
CO 2	Explain the working principles and applications of machine tools such as lathes, shapers, drilling, boring, milling, and grinding machines. (Cognitive Knowledge Level: Understand)
CO 3	Apply advanced techniques for surface finishing, gear cutting, and thread production to achieve precise manufacturing requirements (Cognitive Knowledge Level: Apply)
CO 4	Make use of precision measurement tools to assess limits, fits, tolerances, and dimensional accuracy in manufacturing processes. (Cognitive Knowledge Level: Apply)
CO 5	Apply and utilize advanced metrology tools, including CMM and laser interferometers, to ensure quality control in industrial applications. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	2	-	-	-	-	-	-	-	2
CO 2	3	2	2	-	-	-	-	-	-	-	-	1
CO 3	3	3	3	2	2	-	-	-	-	-	-	2
CO 4	3	3	2	3	1	-	-	-	-	2	-	2
CO 5	3	3	3	3	3	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	50	30	30
Apply	40	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

KNOWLEDGE IS POWER

SYLLABUS

MODULE 1 (8 hours)

Metal cutting: Theory metal cutting in turning, Tool nomenclature, attributes, surface roughness obtainable- Mechanism of metal removal.
Merchant's theory: Mechanics of machining, Merchant's Circle
Types of chips: Mechanism of chip formation –chip breakers. Continuous, discontinuous, and built-up edge chips.
Orthogonal vs. oblique cutting, tool wear, tool life, machinability.

MODULE 2 (10 hours)

General Purpose Machines: Types and classification of machine tools
Lathe: Types and classification of lathe – methods of holding work and tool –lathe accessories and attachments –lathe operations Lathe operations: Turning, Facing, Knurling, taper turning, threading.
Shaper, slotter, and planner: Principles, operations, Quick return mechanisms and applications.
Broaching Machines: Broaching –different machines – cutter for broaching – broaching processes – internal and external broaching
Drilling and boring machines: Specifications, operations, twist drill geometry, tool holding, boring tools and reamers.

MODULE 3 (8 hours)

Milling machines: Milling machines – types and specifications- Milling operations and types of milling cutters used for each. Milling tool nomenclature - Cutting forces in milling.
Calculation of machining time- Indexing head (Simple and Direct) and its applications.
Grinding machines: types of grinding machines-operations: cylindrical, surface and center less grinding – internal grinding, tool and cutter grinding - grinding mechanisms. Grinding wheels: Specification – types of abrasives, grain size -Types of bond, grade, and structure – Marking system of grinding wheels – Selection of grinding wheels –need of better surface finish.
Finishing processes: Lapping, honing, burnishing, comparison of surface textures.

MODULE 4 (9 hours)

Metrology –principles of achieving accuracy –economic machining accuracy – precision vs accuracy - errors- standards of measurements.
Limits, fits, and tolerances: Theory of tolerances and allowances –system of limits and fits – types of fits – interchangeability and selective assembly; Hole and shaft basis system, GO and NO-GO gauges - types, principle of gauge tolerance –wear allowance-gauge materials.
Linear and angular measurements: Vernier caliper, sine bar, bevel protractor, autocollimator.
Surface roughness: CLA, RMS, Rz values, measurement techniques.

MODULE 5 (10 hours)

Gear measurement: Tooth thickness, pitch errors, methods for gear tooth profile generation.
Screw thread measurement: Screw thread measurement – Screw thread terminology; Measurement of major diameter; Measurement of minor or root diameter. Measurement of pitch; Measurement of effective diameter with two wire method and three wire method.
Advanced devices: CMM, Types of CMM; Advantages and application of CMM. CMM probes, types of probes – contact probes and non-contact probes, laser interferometers, Machine Vision – Introduction to machine vision, functions, applications and advantages of machine vision.

Text Books

1. HMT, Production Technology, A practical approach to machine tools and their industrial applications with illustrations. Tata McGraw Hill.
2. I.C. Gupta, A Textbook of Engineering Metrology, Dhanpat Rai & Co.
3. S.K. Hajra Choudhury, Elements of Workshop Technology Vol. II, Media Promoters & Publishers.
4. P.N. Rao, Manufacturing Technology Vol. II, McGraw Hill Education.
5. S.K. Hajra Choudhury, Workshop Technology Vol. II, Media Promoters & Publishers.

Reference Books

1. Serope Kalpakjian and Steven Schmid, Manufacturing Engineering and Technology, Pearson Education.
2. Raghavendra N.V. and Krishnamurthy L., Engineering Metrology and Measurements, Oxford University Press.
3. R.K. Jain, Precision Engineering: Metrology and Instrumentation, Khanna Publishers.
4. David A. Stephenson and John S. Agapiou, Metal Cutting Theory and Practice, CRC Press.
5. S.F. Scarr, Handbook of Metrology and Measurement Systems, Springer.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**8**
1.1	Introduction to metal cutting in turning	1
1.2	Tool nomenclature: Definitions and attributes	1
1.3	Surface roughness obtainable in machining	1
1.4	Mechanism of metal removal in turning	1
1.5	Merchant’s theory: Mechanics of machining and Merchant’s Circle	1
1.6	Types of chips: Continuous, discontinuous, and built-up edge chips	1
1.7	Mechanism of chip formation and chip breakers	1
1.8	Orthogonal vs. oblique cutting: Comparison and applications	1
	Module 2	**10**
2.1	Classification and types of general-purpose machine tools	1
2.2	Lathe: Types, classifications, and overview	1
2.3	Methods of work holding and tool holding in lathes	1
2.4	Lathe accessories and attachments Lathe operations: Turning, facing,	1

2.5	Specialized lathe operations: knurling Taper turning and threading	1
2.6	Shaper machines: Principles, operations, and quick return mechanism	1
2.7	Slotter and planner machines: Principles and applications	1
2.8	Broaching machines: Overview of types and classifications	1
2.9	Internal and external broaching processes and tools	1
2.10	Drilling and boring machines: Specifications and operations	1
	Module 3	**8**
3.1	Types and specifications of milling machines	1
3.2	Milling operations and types of milling cutters	1
3.3	Cutting forces in milling and machining time calculation	1
3.4	Indexing head: Simple and direct indexing techniques	1
3.5	Types and operations of grinding machines	1
3.6	Grinding mechanisms: Cylindrical, surface, and centerless grinding	1
3.7	Grinding wheels: Types, specifications, and selection criteria	1
3.8	Overview of finishing processes: Lapping, honing, and burnishing	1
	Module 4	**9**
4.1	Principles of metrology: Accuracy, precision, and standards	1
4.2	Common measurement errors and their impact (Systematic and Random errors only)	1
4.3	Theory of tolerances and allowances in manufacturing	1
4.4	Limits and fits: Hole and shaft basis system	1
4.5	Types of fits: Clearance, interference, and transition fits	1
4.6	Interchangeability and selective assembly in manufacturing	1
4.7	GO and NO-GO gauges: Types, principles, and design	1
4.8	Linear measurement tools: Vernier caliper and micrometer	1
4.9	Angular measurement tools: Sine bar, bevel protractor, and autocollimator	1
	Module 5	**10**
5.1	Gear measurement: Tooth thickness and pitch errors	1
5.2	Gear profile generation and methods to correct errors	1
5.3	Screw thread measurement: Major, minor, and effective diameters	1
5.4	Two-wire and three-wire methods for screw thread measurement	1
5.5	Coordinate Measuring Machine (CMM): Principles and types	1
5.6	CMM applications and advantages in manufacturing	1
5.7	CMM probes: Contact and non-contact probes	1
5.8	Laser interferometers: Working principles and applications	1
5.9	Introduction to machine vision systems: Overview and features	1
5.10	Machine vision: Industrial functions and applications	1
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Explain the mechanics of metal cutting with the help of Merchant's Circle.
2. Differentiate between orthogonal and oblique cutting with suitable examples.
3. Describe the geometry of a single-point cutting tool and its impact on chip formation.
4. Analyze the effect of cutting forces on tool wear and material removal rate.
5. Discuss the types of chips formed in machining and the conditions that promote their formation.

Course Outcome 2 (CO2):

1. Explain the various operations performed on a lathe, including turning, taper turning, and threading.
2. Describe the quick return mechanism used in shaping machines with a neat sketch.
3. Compare and contrast drilling and boring operations in terms of tools, techniques, and applications.
4. Illustrate the indexing methods used in milling operations with examples.
5. Discuss the types of grinding machines and their applications in surface and cylindrical grinding.

Course Outcome 3 (CO3):

1. Describe the lapping and honing processes and their role in achieving precise surface finishes.
2. Explain gear hobbing and gear shaping methods with neat diagrams.
3. What are the major challenges in thread cutting on a lathe, and how can these be overcome using advanced techniques?
4. Discuss the importance of burnishing in surface finishing and compare it with other methods.
5. Illustrate the steps involved in producing helical gears using advanced machining tools.

Course Outcome 4 (CO4):

1. Define limits, fits, and tolerances, and explain their importance in manufacturing processes.
2. With a neat sketch, explain the construction and working of a GO/NO-GO gauge.
3. Describe the procedure for using a sine bar to measure an angle accurately.
4. Differentiate between unilateral and bilateral tolerance systems with examples.
5. Solve a numerical problem to calculate the dimensional tolerances for a given clearance fit.

Course Outcome 5 (CO5):

1. What are Coordinate Measuring Machines (CMM)? Explain their types and applications in modern manufacturing.
2. Discuss the working principle of a laser interferometer and its use in precision measurement.
3. Explain the concept of gear measurement and how CMM can be used to inspect gear profiles.
4. How do advanced metrology tools contribute to quality control in industrial applications? Provide examples.
5. Compare traditional metrology tools with modern ones like CMM in terms of accuracy, speed, and versatility.

MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, JUNE 2025

Course Code: **B24ME2T05**

Course Name: **METROLOGY AND MACHINE TOOLS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Explain the concept of cutting forces using Merchant's Circle.
2. Differentiate between orthogonal and oblique cutting.
3. What are the advantages of the quick return mechanism in shaping machines?
4. List the key differences between drilling and boring operations.
5. Explain the principle of milling operations.
6. What are the primary differences between lapping and honing?
7. What are the key differences between unilateral and bilateral tolerance systems?
8. Explain the use of slip gauges in linear measurement.
9. What are the different types of Coordinate Measuring Machines (CMM)?
10. Define surface roughness parameters: CLA, RMS, and Rz values

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) Draw and explain the geometry of a single-point cutting tool. (7 Marks)

    b) Discuss the various types of chips formed in machining and the conditions favoring their formation. (7 Marks)

OR

12. a) Analyze the relationship between cutting speed, feed, and depth of cut with tool life. (7 Marks)

    b) Explain the machinability index and factors affecting machinability. (7 Marks)

Module 2

13. a) Explain the working principle of a shaping machine with a neat sketch. (7 Marks)

b) Describe the quick return mechanism used in shaping machines. (7 Marks)

OR

14. a) Discuss the tool geometry of a twist drill with a neat diagram. (7 Marks)

b) Compare and contrast the applications of boring and reaming operations. (7 Marks)

Module 3

15. a) Describe the different types of milling cutters and their applications. (7 Marks)

b) Explain the direct and simple indexing methods used in milling. (7 Marks)

OR

16. a) Explain the construction and working of cylindrical grinding machines. (7 Marks)

b) Discuss the specifications of grinding wheels and their importance in selecting the right wheel. (7 Marks)

Module 4

17. a) Define limits, fits, and tolerances, and explain the hole and shaft basis system with examples. (7 Marks)

b) Explain the working of a GO/NO-GO gauge with a neat diagram. (7 Marks)

OR

18. a) With a diagram, explain the construction and working of an autocollimator. (7 Marks)

b) The specification of a part is given as 50H7d9. The fundamental deviation for *d* is 80 microns and tolerance grade IT7 and IT9 are 25 and 62 microns respectively. With the help of a figure, explain the geometry of the given part. (7 Marks)

Module 5

19. a) Explain the principle of laser interferometry and its application in precision measurement. (7 Marks)

b) Discuss the role of CMM in quality control, with examples of components it can inspect. (7 Marks)

OR

20. a) Explain the methods of gear tooth thickness measurement using the constant chord method. (7 Marks)

b) Compare traditional metrology tools with modern tools like CMM in terms of accuracy and versatility. (7 Marks)

B24ME2T06	ENGINEERING THERMODYNAMICS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

The course on Engineering thermodynamics examines energy, its conversion, and its interaction with matter. This course explores the principles of heat, work, and thermodynamic laws, which are fundamental to designing efficient systems such as engines and power plants. A solid understanding of these concepts is essential for tackling challenges in energy production, consumption, and environmental sustainability.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Understand the Zeroth law of Thermodynamics to define temperature and to apply its basic principles to thermal systems (Cognitive Knowledge Level: Apply)
CO 2	Apply first law of thermodynamics to analyse energy interactions and mass balance in flow and non-flow processes. (Cognitive Knowledge Level: Apply)
CO 3	Apply second law to various processes to determine entropy and availability changes (Cognitive Knowledge Level: Apply)
CO 4	Identify change in properties of pure substances during phase change processes (Cognitive Knowledge Level: Apply)
CO 5	Interpret various property relations and experiment with various power generating thermodynamic cycles. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	2		1	1		1			1
CO 2	3	2	1	2		1	1		1			1
CO 3	3	2	1	2		1	1		1			1
CO 4	3	2	1	2		1	1		1			1
CO 5	3	2	1	2					1			1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	40	40	40
Apply	50	50	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (8 hours)

Role of Thermodynamics and it's applications in Engineering and Science –Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.

MODULE 2 (8 hours)

Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity. First law of Thermodynamics - First law applied to Non flow Process- Flow work, Enthalpy- specific heats, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Limitations of the First Law.

MODULE 3 (10 hours)

Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation, Entropy and Disorder, Isentropic process, Third law of thermodynamics, Available Energy, Availability and Irreversibility- Second law efficiency.

MODULE 4 (10 hours)

Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables. The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State, Compressibility factor, Law of corresponding state, Compressibility charts.

MODULE 5 (9 hours)

General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation.

Analysis of Power Generation Cycles- Ideal Rankine Cycle -Effect of Temperature and Pressure on The Rankine Cycle, Ideal Brayton Cycle, Turbine work, Compressor work and Efficiency.

Text Books

1. Yunus Cengel, et al, "Thermodynamics: An Engineering Engineering Approach", McGraw Hill, 9th Edition, 2019

Reference Books

1. Moran J., Shapiro N. M., "Fundamentals of Engineering Thermodynamics", Wiley, 9th Edition, 2018
2. R. E. Sonntag and C. Borgnakke, "Fundamentals of Thermodynamics", Wiley, 8th Edition, 2012
3. P. K. Nag, "Engineering Thermodynamics", McGraw Hill, 6th Edition, 2017

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**8**
1.1	Role of Thermodynamics and it's applications in Engineering and Science	1
1.2	Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe	2
1.3	Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi-static Process, State, Point and Path function.	2
1.4	Zeroth Law of Thermodynamics, Measurement of Temperature,	1
1.5	Reference Points, Temperature Scales.	2
	Module 2	**8**
2.1	Energy - Work - Pdv work and other types of work transfer, free expansion work,	2
2.2	Heat and heat capacity. First law of Thermodynamics - First law applied to Non flow Process	2
2.3	Flow work, Enthalpy- specific heats, First law applied to Flow Process	1
2.4	Mass and Energy balance in simple steady flow process.	1
2.5	Applications of SFEE, Limitations of the First Law	2
	Module 3	**10**
3.1	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements	1
3.2	Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility	2
3.3	Carnot's theorem and its corollaries	1
3.4	Absolute Thermodynamic Temperature scale.	1
3.5	Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications	2
3.6	Entropy generation, Entropy and Disorder, Isentropic process, Third law of thermodynamics	2

3.7	Available Energy, Availability and Irreversibility- Second law efficiency.	1
	Module 4	**10**
4.1	Pure Substances, Phase Transformations, Triple point, properties during change of phase	2
4.2	T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature	1
4.3	T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables.	2
4.4	The ideal Gas Equation, Characteristic and Universal Gas constants,	1
4.5	Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State,	2
4.6	Compressibility factor, Law of corresponding state, Compressibility charts	2
	Module 5	**9**
5.1	General Thermodynamic Relations – Combined First and Second law equations	1
5.2	Helmholtz and Gibb's functions - Maxwell's Relations	1
5.3	Tds Equations. The Clapeyron Equation	2
5.4	Analysis of Power Generation Cycles- Ideal Rankine Cycle	2
5.5	Effect of Temperature and Pressure on The Rankine Cycle	2
5.6	Ideal Brayton Cycle, Turbine work, Compressor work and Efficiency.	1
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Discuss the different types of systems.
2. Differentiate between Intensive and extensive properties
3. Explain various temperature scales used in engineering

Course Outcome 2 (CO2):

1. A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston –cylinder device. The air is now compressed to a final pressure of 600 kPa . During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process.
2. Carbon dioxide enters an adiabatic nozzle steadily at 1 MPa and 500°C with a mass flow rate of 600 kg/hr and leaves at 100 kPa and 450 m/s. The inlet area of the nozzle is 40 cm2. Determine (a)the inlet velocity and (b) the exit temperature
3. A vertical piston – cylinder device initially contains 0.25 m^3 of air at 600kPa and 300°C. A valve connected to the cylinder is now opened and air is allowed to escape until three-

quarters of the mass leave the cylinder at which point the volume is 0.05 m^3. Determine the final temperature in the cylinder and the boundary work during this process.

Course Outcome 3 (CO3):

1. An adiabatic vessel contains 2 kg of water at 25℃. By paddle – wheel work transfer, the temperature of water is increased to 30℃. If the specific heat of water is assumed to be constant at 4.186 kJ/kg.K, find the entropy change of the universe.
2. Two kilograms of water at 80°C is mixed adiabatically with 3 kg of water at 30°C in a constant pressure process at 1 atm. Find the increase in entropy of the total mass of water due to the mixing process.
3. Argon enters an insulated turbine operating under steady state at 1000℃ and 2 MPa and exhausts at 350 kPa. The mass flow rate is 0.5 kg/s and the turbine develops power at the rate of 120 kW. Determine (a) the temperature of the argon at the turbine exit, (b) the irreversibility of the turbine and (c) the second law efficiency. Take T_o = 20 ℃ and P_o = 1 bar

Course Outcome 4 (CO4):

1. What are the limitations of ideal gas equation and how does Van der Waals equation overcome these limitations?
2. Discuss law of corresponding states and its role in the construction of compressibility chart.
3. A rigid tank contains 2 kmol of N_2 and 6 kmol of CH_4 gases at 200 K and 12 MPa. Estimate the volume of the tank, using (a) ideal gas equation of state (b) the compressibility chart.

Course Outcome 5 (CO5):

1. Plot the T-s diagram of Rankine Cycle. Explain the processes using a schematic.
2. Derive the efficiency of a Brayton cycle.
3. A gas-turbine power plant operating on an ideal Brayton cycle has a pressure ratio of 8. The gas temperature is 300 K at the compressor inlet and 1300 K at the turbine inlet. Using the air-standard assumptions, determine (a) the gas temperature at the exits of the compressor and the turbine, (b) the back work ratio, and (c) the thermal efficiency.

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg.No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

***Course Code:* B24ME2T06**

***Course Name:* ENGINEERING THERMODYNAMICS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Define thermodynamics. List a few of its applications
2. Differentiate between intensive and extensive properties.
3. Differentiate between heat and work.
4. State the first law of thermodynamics for a closed system.
5. Define internal energy and enthalpy.
6. Explain system approach and control volume approach as applied in the analysis of a flow process.
7. An inventor claims to have developed an engine that delivers 26 kJ of work using 82 kJ of heat while operating between temperatures 120°C and 30°C. Is his claim valid? Give the reason for your answer.
8. Define (i) critical point and (ii) triple point, with respect to water.
9. How can you estimate the pump work in Rankine cycle?
10. Derive the efficiency of a Brayton cycle.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) What is meant by thermodynamic equilibrium? What are the essential conditions for a system to be in thermodynamic equilibrium? (7 marks)

    b) Express the temperature of 91°C in (i) Fahrenheit (ii) Kelvin (iii) Rankine. (7 marks)

OR

12. a) Explain macroscopic and microscopic approach to thermodynamics. (7 marks)

    b) With the aid of a suitable diagram, explain the working of constant volume gas thermometer. (7 marks)

Module 2

13. a) A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston –cylinder device. The air is now compressed to a final pressure of 600 kPa. During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process. (7 marks)

    b) A 2 m^3 rigid tank initially contains air at 100 kPa and 22°C. The tank is connected to a supply line through a valve. Air is flowing in the supply line at 600 kPa and 22°C. The valve is opened, and air is allowed to enter the tank until the pressure in the tank reaches the line pressure, at which point the valve is closed. A thermometer placed in the tank indicates that the air temperature at the final state is 77°C. Determine, (i) the mass of air that has entered the tank and (ii) the amount of heat transfer. (7 marks)

OR

14. a) A turbine operates under steady flow conditions, receiving steam at the following conditions: pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3m. The steam leaves the turbine at the following conditions: pressure 20 kPa, enthalpy 25kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42kg/s, what is the power output of the turbine in kW? (7 marks)

    b) State the general energy balance equation for an unsteady flow system and from it, derive the energy balance equation for a bottle filling process, stating all assumptions. (7 marks)

Module 3

15. a) State the Kelvin-Planck and Clausisus statements of the second law of thermodynamics and prove their equivalence. (7 marks)

    b) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40 % of the maximum possible and the COP of the heat pump is 50% of the maximum possible, what is the temperature of the reservoir to which the heat pump rejects heat? What is the rate of heat rejection from the heat pump, if the rate of heat supply to the engine is 50 kW? (7 marks)

OR

16. A house is to be maintained at 21°C during winter and at 26°C during summer. Heat leakage through the walls, windows and roof is about 3000 kJ/hr per degree temperature difference between the interior of the house and the environment. A reversible heat pump is proposed for realising the desired heating and cooling. What is the minimum power required to run the heat pump in the reverse, if the outside temperature during summer is 36°C? Also find the lowest environment temperature during winter for which the inside of the house can be maintained at 21°C consuming the same power. (14marks)

Module 4

17. a) Show the constant pressure transformation of unit mass of ice at atmospheric pressure and -20^{o}C to superheated steam at 220^{o}C on P-v , T-v and P-T coordinate systems and explain their salient features. (7 marks)

    b) A rigid vessel of volume 0.3 m^3 contains 10 kg of oxygen at 300 K. Using (i) the perfect gas equation and (ii) the Van der Waal's equation of state, determine the pressure of oxygen in the vessel. Take the Van der Waal's constants for oxygen as a =0.1382 m^6 Pa/ mol^2 and b=0.03186 m^3/ kmol . (7 marks)

OR

18. a) Steam at 25 bar and 300^{o}C expands isentropically to 5 bar. Calculate the change in enthalpy, volume and temperature of unit mass of steam during this process using steam tables and Mollier chart and compare the values. (7 marks)

19. b) Explain law of corresponding states and its significance to the generalized compressibility chart. (7 marks)

Module 5

20. Steam at a pressure of 15 bar and 250^{o}C is expanded through a turbine to a pressure of 4 bar. It is then reheated at constant pressure to initial temperature of 250^{o}C and finally expanded to condenser pressure of 0.1 bar. Calculate efficiency of the cycle. What will be the efficiency if reheating is not employed? Pump work can be neglected. (14 marks)

OR

21. Derive the Maxwell's equations. (14 marks)

<table>
<tr><td rowspan="2">B24HU2T01</td><td rowspan="2">BUSINESS ECONOMICS AND FINANCIAL MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2024</td></tr>
</table>

Preamble: This course will aid and equip the students to comprehend the various concepts in Business Economics and Finance. They will gain an understanding of price, demand, production, costs and revenue. They will also learn about the functioning of various markets and fathom the problems affecting the world of business. They will be introduced to national income accounting and to the financial tools used in personal finance. The students will also gain an insight into business financing and the functioning of the stock market.

Prerequisite: Nil

Course outcomes: After the completion of the course the students will be able to:

CO 1	Understand the fundamental concepts and theories of demand, supply, and production to various related economic issues. **(Cognitive Knowledge Level: Understand)**
CO 2	Understand the concepts relating to costs and revenue to the functioning of firms in different market situations and solve simple business problems using break even analysis. **(Cognitive Knowledge Level: Understand)**
CO 3	Apply the basic macroeconomic principles to economic concepts influencing the economy as a whole like national income accounting, monetary and fiscal policy, balance of payments and international trade. **(Cognitive Knowledge Level: Apply)**
CO 4	Make use of the possibilities of financial management to acquire knowledge in the functioning of the Indian financial system and evaluate decisions regarding personal finance. (**Cognitive Knowledge Level: Apply)**
CO 5	Develop decision making capability by acquiring knowledge in stock markets, mutual funds, business financing and international financing. **(Cognitive Knowledge Level: Apply)**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1	1	1	1	-	-	-	-	1	1
CO 2	1	1	1	1	1	1	-	-	-	-	1	1
CO 3	1	1	1	1	1	1	1	-	-	-	2	1
CO 4	1	1	1	1	1	2	-	1	1		2	2
CO 5	1	1	1	1	2	2	-	1	1		2	2

Assessment Pattern

	Business Economics and Financial Management		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (% Marks)**
	Test 1 (% Marks)	**Test 2 (% Marks)**	
Remember	50	30	30
Understand	50	40	40
Apply		30	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 Marks
Continuous Assessment Test (2numbers) : 25 Marks
Assignment/Quiz/Course project : 15 Marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions carrying 3 marks each. Part B contains 2 questions from each module out of which 1 to be answered. Each question carries 14 marks and can have maximum 2 sub divisions.

SYLLABUS

Module 1
Fundamentals of Business Economics (8 Hours)

Introduction – Demand and its determinants – Law of demand – Elasticity of demand: Price, Income and Cross - Measurement of elasticity and its applications (Numerical problems) – Supply and its determinants – Determination of Equilibrium Price – Changes in demand and supply and its effects Utility – Law of diminishing marginal utility - Consumer surplus - Producer surplus.

Production concepts: Production function - Cobb Douglas function (Numerical problems) - Average product - Marginal product - Law of variable proportions – Law of Returns to Scale.

Module 2
Cost, Revenue and Markets (7 Hours)

Concepts of cost: Opportunity cost - Explicit and implicit cost – Private and social cost- Short run cost curves – Fixed, variable, total, average and marginal cost curves - Long run cost curves.

Concepts of revenue: Average and marginal revenue - Shutdown point - Break Even analysis (Numerical problems).

Markets: Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly - Cartel and Collusion (Features and equilibrium of a firm) - Product pricing: Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming – Administered pricing.

Module 3
National Income, Inflation and International Trade (7 Hours))

Circular flow of income - Multi-sector model - National income concepts: GNP, GDP, NNP, NI, PI, DPI, PCI - Methods of measuring national income – Difficulties (Numerical problems).

Inflation –Types - Causes and effects – Measures to control inflation - Monetary and fiscal policies – Deflation.

International Trade - Balance of payments – Components – Deficit - Devaluation – Tariff and non-tariff barriers.

Module 4
Fundamentals of Financial Management (7 hours)

Introduction - Reserve Bank of India – Functions - Credit control techniques: Quantitative and qualitative techniques - Working capital management - Factors affecting working capital - Management of cash and marketable securities - Receivables management - Balance Sheet - Profit and Loss Account.

Personal Finance: Personal budget – Tracking income and expenses - 50-30-20 budgeting rule – Emergency fund – Debit vs Credit instruments – Diversification of Investments –Shares vs Bonds - Power of Compounding – Financial independence – Types of Insurance - Digital technology in Finance.

Module 5
Business Financing (7 hours)

Introduction: The Stock Market: Functions, Problems faced by the stock market in India – Demat account and trading account – Market indices: Sensex and Nifty - Derivatives: Forwards, Futures, Options, Swaps - Mutual Funds – Types.

Sources of business financing: Equity capital - Preference capital - Debenture capital - Term loans - Retained earnings - Money market – Instruments - International Financing - FDI, FII.

Text Books

1. Dominic Salvatore "Principles of Microeconomics", Oxford University Press, 2009
2. Gregory N Mankiw, "Principles of Macro Economics", Cengage Leaning India, 2022.
3. Prasanna Chandra, "Financial Management", McGraw Hill, 2022

Reference Books

1. Paul A Samuelson, "Economics", McGraw Hill, 2019.
2. A. Koutsoyiannis, "Modern microeconomics", Palgrave McMillan, 1979.
3. Geetika Piyali Ghosh and Chodhury "Managerial Economics", McGraw Hill, 2017.
4. M Y Khan & P K Jain, "Financial Management", McGraw Hill, 2018.
5. Ruddar Datt, Indian Economy", S.Chand and Company Ltd, 2018.
6. Dwivedi D N, "Macro Economics", McGraw Hill, 2018.
7. Gregory N Mankiw, "Principles of Micro Economics", Cengage Leaning India, 2020
8. James C Van Horne, "Financial Management and Policy", Pearson Education, 20

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture /Tutorial hours
1	**Module 1 (Fundamentals of Business Economics)**	**8**
1.1	Introduction - Demand and its determinants – Law of demand – Elasticity of demand – Measurement of elasticity and its applications (Numerical problems).	2
1.2	Supply and its determinants – Determination of equilibrium price – Changes in demand and supply and its effects.	2
1.3	Law of diminishing marginal utility - Consumer surplus - producer surplus	2
1.4	Production concepts: Production function - Cobb Douglas function (Numerical problems) - Average product - Marginal product - Law of variable proportions - Law of Returns to Scale.	2
**Activity 1: OPEC decides to reduce its output of oil. Using demand and supply curves bring out the effect of this on the price of oil in the world market.*		

Activity 2: Derive the determination of the equilibrium price of a super luxury and an economy car.		
2	**Module 2 (Cost, Revenue and Markets)**	**7**
2.1	Concepts of cost - Opportunity cost - Explicit and implicit cost – Private and social cost- Short run cost curves – Fixed, variable, total, average and marginal cost curves - Long run cost curves.	2
2.2	Concepts of revenue – Average and marginal revenue - Shutdown point – Break Even analysis (Numerical problems).	2
2.3	Markets: Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly - Cartel and Collusion (Features and equilibrium of a firm).	2
2.4	Product pricing: Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming – Administered pricing.	1
Activity 1: Determination of equilibrium price and output in oligopoly companies in India. *Activity 2: Pricing strategy followed by Apple in regard to their mobiles.*		
3	**Module 3 (National Income, Inflation and International Trade)**	**7**
3.1	Circular flow of income - Multi-sector model - National income concepts – GNP, GDP, NNP, NI, PI, DPI, PCI - Methods of measuring national income – Difficulties (Numerical problems).	2
3.2	Inflation –Types - Causes and effects – Measures to control inflation - Monetary and fiscal policies – Deflation.	2
3.3	International Trade - Balance of payments – Components – Deficit.	2
3.4	Devaluation — Tariff and non-tariff barriers.	1
Activity 1: Compare the present BoP position of India and China. *Activity 2: Impact of tariff wars in today's global scenario.*		
4	**Module 4 (Financial Management)**	**7**
4.1	Introduction - Reserve Bank of India – Functions - Credit control techniques: Quantitative and qualitative techniques.	2
4.2	Working capital management - Factors affecting working capital.	1
4.3	Management of cash and marketable securities - Receivables management. Balance Sheet - Profit and Loss Account.	2
4.4	Personal Finance: Budget – Tracking income and expenses - 50-30-20 budgeting rule – Emergency fund – Debit vs Credit Cards – Diversification of Investments – Shares vs Bonds - Power of Compounding – Financial independence – Insurance – Types of Insurance - Digital technology in Finance.	2
Activity 1: Investigate the historical returns offered by different asset classes. *Activity 2: Steps needed to circumnavigate financial challenges like student loans, buying a car, purchasing a home vs renting etc.*		
5	**Module 5 (Business Financing)**	**7**
5.1	Introduction - The Stock Market – Functions, Problems faced by the stock market in India – Demat account and trading account – Market indices: Sensex and Nifty.	3
5.2	Derivatives: Forwards, Futures, Options, Swaps - Mutual Funds – Types.	1

5.3	Sources of business financing: Equity capital - Preference capital - Debenture capital - Term loans - Retained earnings.	2
5.4	International Financing - FDI, FII.	1
Activity 1: Research and present the stock performance of a company. *Activity 2: Investigate the impact of foreign direct investment into India taking the examples of multinational companies.*		
	Total	**36 hours**

* Activities are a desirable part of the course.

CO ASSESSMENT QUESTIONS

Course Outcome 1 CO1):

1. State the Law of demand.
2. With the help of a figure, elucidate the concept of consumer surplus.
3. Define utility. State the Law of diminishing marginal utility.

Course Outcome 2 (CO2):

1. Distinguish between explicit and implicit cost.
2. Bring out the relationship between average and marginal revenue.
3. How does a firm under monopoly attain equilibrium?

Course Outcome 3 (CO3):

1. With the help of a figure, examine the circular flow of income in a multi sector economy.
2. State the government measures to control inflation.
3. What are non-tariff barriers? Give two examples.

Course Outcome 4 (CO4):

1. Mention any four functions of the RBI.
2. Elucidate the concept of working capital management. State the main factors influencing it.
3. Clarify the significance of an emergency fund? Mention its advantages.

Course Outcome 5 (CO5):

1. Elucidate the main problems faced by the stock market in India.
2. Clarify the significance of mutual funds? Mention the main types of mutual funds.
3. Distinguish between FDI and FII.

KNOWLEDGE IS POWER

Model Question Paper

QP CODE: Pages: 3

Reg No.:____________________

Name:______________________

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS) KOTHAMANGALAM

THIRD SEMESTER B. TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24HU2T01**

Course Name: **BUSINESS ECONOMICS AND FINANCIAL MANAGEMENT**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. With the help of a figure, elucidate the concept of consumer surplus.
2. A tea company sold 40000 kg of tea when the price of coffee was Rs.50 per kg. Later they were able to sell 45000 kg when the price of coffee increased to Rs.70 per kg. Calculate the cross elasticity of demand for tea.
3. Distinguish between explicit and implicit cost.
4. List the features of a firm under perfect competition.
5. Define cost plus pricing. Mention its advantage.
6. Write a note on non-tariff barriers. Give two examples.
7. Define Cash Reserve Ratio.
8. Write a note on the significance of receivables management.
9. Distinguish between demat account and trading account.
10. What is FDI? Mention two of its merits.

PART B

Answer any one question from each module. Each question carries 14 marks.

MODULE 1

11a. State the Law of Demand. Also mention the assumptions and exceptions of the law (7 Marks)

b. What is the Cobb- Douglas production function? Mention its feature. If the production function of a firm is $Q = 30\, L^{1/2}K^{1/2}$, find out the average and marginal product of labour from the function, if 225 units of labour (7 Marks) is combined with 196 units of capital

OR

12a. State the Law of diminishing marginal utility. Also mention the assumptions and importance of the law (7 Marks)

b. Define Income elasticity. When the income of a consumer was Rs. 50000 per month, the quantity demanded of a good was 100 units. When his income increased to Rs.80000, his demand increased to 110 units. Is the good a normal or an inferior one? Give reason. (7 Marks)

MODULE 2

13a. State the features of a firm under perfect competition. With the help of a figure, explain the determination of equilibrium price and output under perfect competition (7 Marks)

b. A firm sells its product at Rs.400 per unit. To produce a unit, it needs raw materials for Rs. 150, labour for Rs.70 and incurs other variable expenses for Rs. 40.The firms fixed expenses are Rs.15,00,000. Find the breakeven quantity of the firm. (7 Marks)

OR

14a. State the features of a firm under monopolistic competition. With the help of a figure, explain the determination of equilibrium price and output under monopolistic competition (7 Marks)

b. The value of the total sales of a company is Rs. 100000. Its fixed cost is Rs. 20000, while its variable cost is Rs.50000. Calculate
(a) the P/V ratio
(b) breakeven point
(c) Margin of safety at this level of sales
(d) If it sells each unit for Rs.20, how many units should the company sell to break even?
(e) Find the sales required to earn a profit of Rs.20000. (7 Marks)

MODULE 3

15a. With the help of a figure, examine the circular flow of income in a multi sector economy. (7 Marks)

b. From the following data,

(a) Gross National Product = Rs 14700 crores
(b) GST = Rs 1100 crores
(c) Undisbursed Profit = Rs 2000 crores
(d) Corporate Income Tax = Rs 1000 crores
(e) Depreciation = Rs 1500 crores
(f) Net Factor Income from abroad = Rs 5200 crores
(g) Income Tax = Rs 500 crores
(h) Subsidies = Rs 400 crores
(i) Social Security Contribution = Rs 300 crores

Calculate
(i) GDP
(ii) NI
(iii) PI (7 Marks)

OR

16a. Elucidate the economic problem of inflation. What are its main types? (7 Marks)

State the government measures to control inflation.

b. In an economy, the total expenditure of the people on various goods and services is Rs 2000 crores. The government spending is Rs 500 crores while the total investment is Rs 300 crores. Exports are Rs 200 crores and imports are Rs. 100 crores. The depreciation is Rs 80 crores. Find the value of GNP. (7 Marks)

MODULE 4

17a. Discuss the functions of the RBI. What are the main quantitative techniques used by the RBI? (7 Marks)

b. State the meaning of balance sheet in accounting. Draw a format of the balance sheet showing the different entries. (7 Marks)

OR

18a. Write a note on the management of cash and marketable securities. (7 Marks)

b. State the significance of profit and loss account. Illustrate a format of the profit and loss account. (7 Marks)

MODULE 5

19a. Elaborate the main functions performed by the stock market in an economy. (7 Marks)

b. Elucidate the various sources of business financing available to companies. (7 Marks)

OR

20a. Elaborate the meaning of mutual funds. Discuss the different types of mutual funds (7 Marks)

b. Distinguish between FDI and FII. (7 Marks)

KNOWLEDGE IS POWER

<table>
<tr><td rowspan="2">B24ME2T07</td><td rowspan="2">FLUID MACHINES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>2</td><td>3</td><td>2024</td></tr>
</table>

Preamble

This course is designed to equip students with a comprehensive understanding of machines that operate using fluids, including pumps, turbines, compressors, and hydraulic systems. Through this course, students will develop the ability to apply their understanding of fluid machines to real-world engineering scenarios. By exploring various applications in industries such as power generation, transportation, and manufacturing, they will gain the confidence to solve complex engineering problems, optimize system performance, and contribute to advancements in fluid-based technologies.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply knowledge to calculate forces and work done by a jet and to explain turbine working while selecting an appropriate turbine for specific applications. (Cognitive Knowledge Level: Apply)
CO 2	Understand the working of an axial flow turbine and the relevance of a draft tube. (Cognitive Knowledge Level: Understand)
CO 3	Understand the characteristics of rotodynamic pumps and evaluate their performance. (Cognitive Knowledge Level: Understand)
CO 4	Apply fluid mechanics principles to analyze and select positive displacement pumps and related devices for efficient operation in engineering systems. (Cognitive Knowledge Level: Apply)
CO 5	Apply principles of thermodynamics and fluid mechanics to analyze the performance, efficiency, and operation of various compressors and their components in engineering applications. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2								1
CO 2	3	3	3	2								1
CO 3	3	3	3	2								1
CO 4	3	3	3	2								1
CO 5	3	3	3	2								1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	50	30	30
Apply	40	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

KNOWLEDGE IS POWER

SYLLABUS

MODULE 1 (8 hours)

Impact of jets: Introduction to the hydrodynamic thrust of jet on a fixed and moving surface (flat and curve), Series of vanes, work done and efficiency.
Hydraulic Turbines: Classification of Turbines, Applications, Impulse and Reaction Turbines.
Pelton Wheel: Constructional features, Velocity triangles, Euler's equation, Speed ratio, jet ratio and work done, losses and efficiencies, design of Pelton wheel.
Inward and outward flow reaction turbines: Francis Turbine, Degree of reaction, Constructional features, Velocity triangles, work done and efficiencies.

MODULE 2 (6 hours)

Axial flow turbine (Kaplan): Constructional features, Velocity triangles, work done and efficiencies; theory of draft tubes; surge tanks; Cavitation in turbines; Governing of turbines; Specific speed of turbine; Type Number; Scale Laws; unit speed, unit discharge and unit power.

MODULE 3 (7 hours)

Rotodynamic pumps: Centrifugal pump impeller types, velocity triangles, manometric head, work, efficiency and losses, Cavitation in centrifugal pumps; Maximum suction lift, NPSH required and available; Type number; Pumps in series and parallel operations; Performance characteristics; Specific speed.

MODULE 4 (7 hours)

Positive displacement pumps: Reciprocating pump; Single acting and double acting; slip, negative slip, and work required and efficiency indicator diagram, acceleration head, effect of acceleration and friction on indicator diagram, speed calculation.
Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps; Multistage pumps; selection of pumps; pumping devices; Jet pumps; gear pumps; vane pump and lobe pump.

MODULE 5 (8 hours)

Compressors: classification of compressors; Reciprocating compressor- single stage compressor, equation for work with and without clearance volume, efficiencies, multistage compressor, intercooler, free air delivery (FAD).
Centrifugal compressor-working; surging and chocking; Axial flow compressors: - working; Roots blower, vane compressor, screw compressor.

Text Books

1. S. K. Som, Gautam Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill, 3rd ed., 2017.
2. Bansal R. K. A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 9th ed., 2019.
3. Rajput R. K, Textbook of Fluid Mechanics and Hydraulic Machines, S. Chand, 6th ed., 2016.

Reference Books

1. Yunus A. Cengel and John. M. Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw Hill, 4th ed., 2019.
2. Yahya S. M, Turbines, Compressors and Fans, McGraw Hill, 4th ed., 2017.
3. Subramanya K., Fluid Mechanics and Hydraulic Machines – Problems and Solutions, McGraw Hill, 2nd ed., 2018.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**8**
1.1	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve), Series of vanes, work done and efficiency.	3
1.2	Hydraulic Turbines: Classification of Turbines, Applications, Impulse and Reaction Turbines.	1
1.3	Pelton Wheel: Constructional features, Velocity triangles, Euler's equation, Speed ratio, jet ratio and work done, losses and efficiencies, design of Pelton wheel.	2
1.4	Inward and outward flow reaction turbines: Francis Turbine, Degree of reaction, Constructional features, Velocity triangles, work done and efficiencies.	2
	Module 2	**6**
2.1	Axial flow turbine (Kaplan): Constructional features, Velocity triangles, work done and efficiencies	2
2.2	Theory of draft tubes	1
2.3	Surge tanks; Cavitation in turbines; Governing of turbines	1
2.4	Specific speed of turbine; Type Number; Scale Laws	1
2.5	Unit speed, unit discharge and unit power	1
	Module 3	**7**
3.1	Rotodynamic pumps: Centrifugal pump, impeller types, velocity triangles, manometric head	2
3.2	Work, efficiency and losses	2
3.3	Cavitation in centrifugal pumps; Maximum suction lift, NPSH required and available	2
3.4	Type number; Pumps in series and parallel operations; Performance characteristics, Specific speed	1
	Module 4	**7**
4.1	Positive displacement pumps: Reciprocating pump; Single acting and double acting; slip, negative slip, and work required and efficiency indicator diagram	2
4.2	Acceleration head, effect of acceleration and friction on indicator diagram, speed calculation	2
4.3	Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps	1
4.4	Multistage pumps; selection of pumps; pumping devices	1
4.5	Jet pumps; gear pumps; vane pump and lobe pump	1

	Module 5	8
5.1	Compressors: classification of compressors; Reciprocating compressor: single stage compressor	1
5.2	Equation for work with and without clearance volume	2
5.3	Efficiencies, multistage compressor, intercooler, free air delivered (FAD).	2
5.4	Centrifugal compressor-working	1
5.5	Surging and choking	1
5.6	Axial flow compressors: - working; Roots blower, vane compressor, screw compressor	1
	Total	**36 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Prove that the force exerted by a jet of water on a fixed semi-circular plate in the direction of the jet when the jet strikes at the centre of the semi-circular plate is two times the force exerted by the jet on a fixed vertical plate.
2. A jet of water moving at 60 m/s is deflected by a vane moving at 25 m/s in a direction at 30 degrees to the direction of the jet. The water jet leaves the blade normally to the motion of the vanes. Draw the inlet and outlet velocity triangles and find the vane angles for no shock at entry or exit. Take the relative velocity at the outlet to be 0.85 of the relative velocity at the inlet.
3. Explain the purpose of providing scroll casing and guide vanes for a reaction turbine.
4. In a Pelton wheel turbine, the runner of the turbine is provided with double hemi spherical cup shaped buckets instead of a single curved blade. why?
5. The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 400 m. One-third of the gross head is lost due to friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is 3.0 m3/s and the angle of deflection of the jet is 160 degrees. Determine the power given by water to the runner and the hydraulic efficiency of the Pelton wheel. The speed ratio = 0.48 and Cv = 0.98.

Course Outcome 2 (CO2):

1. What is meant by the specific speed of a turbine? What is its significance?
2. Explain the purpose and working principle of a surge tank in a hydraulic system.
3. Explain the theory of the draft tube in the reaction turbine. How is the turbine performance affected in the absence of draft tube?
4. A Kaplan turbine is designed to develop 9MW power while operating under a net head of 7m. The speed ratio based on outer diameter and flow ratios are to be 2.09 and 0.68 respectively and the ratio of outer to hub diameter is 3. Assuming an overall efficiency of 85%, find the speed and specific speed of the turbine.

Course Outcome 3 (CO3):

1. A centrifugal pump lifts 2.5 m^3/min of water to a height of 20m through a pipeline of 10 cm diameter. The total length of the pipeline is 11 0m. Assuming an overall efficiency of 75% and an inlet loss of 0.3m, find the power required to drive the pump. Take coefficient of friction f = 0.012
2. What is meant by cavitation in a centrifugal pump? What are the effects of cavitation? How it can be eliminated
3. Define the minimum starting speed of a centrifugal pump. Write down the equation for the same with notations.
4. What is meant by the manometric head of a centrifugal pump? What are the different ways of finding it?

Course Outcome 4 (CO4):

1. The bore and stroke of a double-acting reciprocating pump are 15cm and 30cm respectively. The suction and delivery heads are 3m and 30m and the pump delivers 0.62m3/min when running at 60rpm. Find the percentage slip and power required to run the pump if mechanical efficiency is 80%.
2. With the help of the necessary sketch, explain the working of a jet pump. Where are they used?
3. Show that the saving in work done against friction in a double-acting reciprocating pump fitted with an air vessel is 39.2%
4. Reciprocating pumps are called positive displacement pumps why?

Course Outcome 5 (CO5):

1. Draw the indicator diagram of a single-acting reciprocating compressor with clearance volume and explain the working. Also, derive the expression for work done in terms of pressure ratio and effective swept volume.
2. A double-acting single-stage reciprocating compressor delivers air at the rate of 15 m^3/min. (1 bar, 15 ^{0}C). The suction pressure and temperature in the cylinder are 1 bar and 32 Degree Celsius. The delivery pressure is 7 bar and the compression and expansion index is 1.3. The clearance volume is 5% of the swept volume. Calculate indicated power and volumetric efficiency.
3. Write short notes on (i) FAD (ii) isothermal efficiency (iii) intercooler (iv) clearance ratio in connection with a reciprocating compressor.
4. With a neat sketch elaborate on the working of a centrifugal compressor
5. Explain the working of (i) vane compressor and (ii) screw compressor

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24ME2T07**

Course Name: **FLUID MACHINES**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Show that the force exerted by a jet of water on an inclined fixed plate in the direction of the jet is given by: $F_x = \rho A V^2 Sin^2\alpha$.
2. Explain the purpose of providing scroll casing and guide vanes for a reaction turbine.
3. Explain the working of a draft tube in an axial reaction turbine with a neat sketch. What is the reason for the absence of a draft tube in an impulse turbine?
4. Define the specific speed of a turbine and derive the expression for it. Explain the significance of specific speed in the selection of a turbine.
5. What is the priming of a centrifugal pump? Explain clearly why priming is essential before starting a centrifugal pump.
6. Explain the terms manometric efficiency, mechanical efficiency and overall efficiency as applied to centrifugal pumps.
7. Define slip, percentage slip and negative slip of a reciprocating pump
8. Explain in brief how and when separation of flow takes place in a reciprocating pump.
9. Explain 'Surging' in centrifugal compressor
10. Compare axial flow compressor with centrifugal flow compressor.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) Show that for a series of curved radial vanes, the work done by the jet per second is given by: $\rho a V1[V_{W1}\, u1 \pm V_{W2}\, u2]$ (7 marks)

    b) A free jet of water of area A and velocity V strikes a vertical plate normally. The plate is moving with a velocity u in the direction of the jet. Obtain the value of the ratio u/V for maximum efficiency of this power transmission system. What is the value of corresponding maximum efficiency? (7 marks)

OR

12. a) A jet of water having a velocity of 40 m/s strikes a curved vane, which is moving with a velocity of 20 m/s. The jet makes an angle of 30^0 with the direction of motion of the vane at the inlet and leaves at an angle of 90^0 with the direction of motion of the vane at the outlet. Draw the velocity triangles at the inlet and outlet and determine the vane angles at the inlet and outlet so that the water enters and leaves the vane without shock. (7 marks)

b) Prove that the work done per second per unit weight of water in a reaction turbine is given by $1/g\ (V_{W1}\ u1 \pm V_{W2}\ u2)$. (7 marks)

Module 2

13. a) What is the purpose of surge tank and explain its types (7 marks)

b) What is a draft tube? Explain its functions and draw simple sketches of any two types of draft tubes. (7 marks)

OR

14. a) Define the specific speed of a turbine. Derive an expression for it. (5 marks)

b) An inward flow reaction turbine has external and internal diameters of 1.0 m and 0.6 m respectively. The hydraulic efficiency of the turbine is 90 % when the head on the turbine is 36 m. The velocity of flow at the outlet is 2.5 m/s and discharge at the outlet is radial. If the vane angle at the outlet is 15 degrees and the width of the wheel is 100 mm at the inlet and outlet, determine: (i) The guide blade angle (ii) the Speed of the turbine (iii) the Vane angle of the runner at inlet (iv) Volume flow rate of the turbine (v) Power developed. (9 marks)

Module 3

15. a) A centrifugal pump lifts 2.5 m3/min of water to a height of 20m through a pipeline of 10cm diameter. The total length of the pipeline is 110 m. Assuming an overall efficiency of 75% and an inlet loss of 0.3 m, find the power required to drive the pump. Take the coefficient of friction f = 0.012. (9 marks)

b) What is meant by cavitation in a centrifugal pump? What are the effects of cavitation? How it can be eliminated. (5 marks)

OR

16. a) Define the minimum starting speed of a centrifugal pump. Write down the equation for the same with notations. (7 marks)

b) What is meant by the manometric head of a centrifugal pump? What are the different ways of finding it? (7 marks)

Module 4

17. a) Show that the saving in work done against friction in a double-acting reciprocating pump fitted with an air vessel is 39.2%. (7 marks)

b) With the help of the necessary sketch, explain the working of a jet pump. Where are they used? (7 marks)

OR

18. The bore and stroke of a double-acting reciprocating pump are 15cm and 30cm respectively. The suction and delivery heads are 3m and 30m and the pump delivers $0.62m^3$/min when running at 60rpm. Find the percentage slip and power required to run the pump if mechanical efficiency is 80%. (14 marks)

Module 5

19. a) Deduce an equation for the work done on a reciprocating compressor in terms of pressure ratio using a P-V diagram. Assume the process of compression follows polytropic according to pv^n = a constant. (7 marks)

    b) A single-stage single-acting reciprocating air compressor is used to compress $7x10^{-3}$ m^3/min of air from a pressure of 1.013 bar to 14 bar. The index of polytropic compression is 1.3 and mechanical efficiency is 82%. Determine the volumetric efficiency and power required to drive the compressor if the clearance is 3% of the swept volume. (7 marks)

OR

20. a) Obtain the expressions for volumetric efficiency of an air Compressor in terms of clearance ratio, index of compression and pressure ratio. (7 marks)

    b) Prove that for a multi-stage compressor with perfect intercooling between stages, the work done is minimal when the intermediate pressure is the geometric mean of the suction and delivery pressure between successive stages. (7 marks)

B24ME2L04	MECHANICAL MEASUREMENTS LAB	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	2	2024

Preamble

This course is designed to equip students with a comprehensive understanding of advanced measurement techniques and metrology principles, emphasizing precision and quality assurance in manufacturing processes. Students will gain hands-on experience with modern instruments and methods essential for industrial applications. This course integrates classical and contemporary approaches to dimensional, geometric, and surface measurement, aligning with the evolving needs of industries focused on automation, quality control, and advanced manufacturing technologies. By bridging theoretical concepts with practical experiments, this course ensures readiness for roles in modern industrial environments, including sectors like automotive, aerospace, and precision engineering.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Apply precision measurement techniques to evaluate linear dimensions, angles, surface roughness, and bore profiles using advanced metrological tools such as profilometers, optical instruments, and slip gauges. (Cognitive Knowledge Level: Apply)
CO 2	Analyze geometric errors, including straightness, flatness, roundness, and squareness, using state-of-the-art instruments like auto-collimators and surface plates to ensure product quality. (Cognitive Knowledge Level: Analyze)
CO 3	Build proficiency in screw thread and gear parameter measurement using toolmaker’s microscopes, comparators, and profile projectors, critical for gear and thread manufacturing industries. (Cognitive Knowledge Level: Apply)
CO 4	Apply skills in industrial instrumentation and automation by conducting experiments in strain gauge load measurement and tachometry preparing for roles in advanced manufacturing setups. (Cognitive Knowledge Level: Apply)
CO 5	Analyze and interpret manufacturing tolerances and surface finish requirements, ensuring compliance with industrial standards for high-precision components in modern engineering applications. (Cognitive Knowledge Level: Analyze)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	-	3	3							2
CO 2	3	3	-	3	3							2
CO 3	3	2	-	3	3							1
CO 4	3	2	3	3	3					1	2	2
CO 5	3	3	2	3	3							2

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Class work/ Assessment /Viva-voce : 20 marks
Test /Viva voce : 15 marks
Record : 5 marks

End Semester Examination Pattern

Experiment part : 70 marks
Viva voce : 30 marks

Guidelines for award of marks for the experiment part:

Preliminary work : 15Marks
Implementing the work/Conducting the experiment : 25 Marks
Performance, result and inference : 30 Marks

KNOWLEDGE IS POWER

SYLLABUS

LIST OF EXPERIMENTS

Minimum **10** experiments are mandatory (Including study)

1	**Experiments on Repeatability and Reproducibility** Study and analysis of repeatability and reproducibility of given batch of steel balls. etc.
2	**Linear measurements** Study of different linear measuring instruments etc. Calibration of LVDT using slip gauges
3	**Straightness error measurement** To check straightness error of a straight edge by the wedge method using slip gauges. Measurement of straightness error of a CI surface plate using auto collimator and comparing
4	**Out of roundness measurement** Measurement of out of roundness using V-block and dial gauge
5	**Screw thread measurement** Measurement of screw thread parameters using two wire and three wire method.
6	**Bore measurement** Measurement of a bore by three ball method.
7	**Gear Metrology** Study of types of gears – gear terminology; gear errors - Profile Projector. Measurement of profile error and gear parameters using profile projector etc.
8	**Use of Tool maker's microscope** Study of tool maker's microscope – use at shop floor applications. Measurement of different angles of single point cutting tool using tool maker's microscope.
9	**Surface roughness measurement** Measurement of surface roughness using surface profilometer /roughness measuring machine of turned, milled, grounded, lapped and glass etc specimens.
10	**Rotation measurement** Determination of rpm using tachometer, optical tachometer and stroboscope, etc.
11	**Strain Gauges Measurement** Load Measurement using Strain Gauges
12	**Angular Measurement** Measurement of Angle using Sine Bar
13	**Gauge Design** Determine the size of GO and NO- GO gauge using Slip Gauges
14	**Squareness measurement** Determination of squareness of a tri-square using angle plate and slip gauges etc.

Reference Books

1. Raghavendra, N.V., Krishnamurthy, L.; Engineering Metrology and Measurements; Oxford University Press, 2013Bansal R.K, Fluid Mechanics and Hydraulic Machines (SI Units); Laxmi Publications, 2011.
2. Galyer, J.F.W., Shotbolt, C.R.; Metrology for Engineers; ELBS, London, 1990Graebel. W. P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
3. Dotson, Connie; Fundamentals of Dimensional Metrology; Cengage Learning, 2015
4. Beckwith, T.G., Marangoni, R.D., Lienhard, J.H.; Mechanical Measurements; Pearson Education, 2007
5. Pandey, P.C., Shan, H.S.; Modern Machining Processes; Tata McGraw Hill, 2000
6. Jain, V.K.; Precision Engineering: A Practical Guide to Dimensional Accuracy; CRC Press, 2001
7. Doebelin, Ernest O., Manik, Dhanesh N.; Measurement Systems: Application and Design; McGraw Hill, 2011
8. Bewoor, Anand K., Kulkarni, Vinay A.; Metrology and Measurement Systems; Tata McGraw Hill, 2009

KNOWLEDGE IS POWER

B24ME2L05	FLUID MECHANICS AND MACHINES LAB	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		0	0	3	3	2	2024

Preamble

The fluid mechanics and machines laboratory provides students with practical experience in understanding the behavior of fluids and the operation of fluid machinery. It focuses on key principles of fluid statics, fluid dynamics, and the performance of various fluid machines such as pumps and turbines.

Prerequisite

Nil.

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Calibrate flow measuring devices, such as venturimeter, orifice meter, and notches. (Cognitive Knowledge Level: Apply)
CO 2	Apply experimental methods to assess the performance of Pelton, Kaplan, and Francis turbines. (Cognitive Knowledge Level: Apply)
CO 3	Apply performance evaluation tests on hydraulic pumps, including centrifugal, reciprocating, self-priming, and gear pumps. (Cognitive Knowledge Level: Apply)
CO 4	Test for the losses and hydraulic coefficients in pipe and channel flows. (Cognitive Knowledge Level: Analyze)
CO 5	Analyze the metacentric height and radius of gyration of floating bodies. (Cognitive Knowledge Level: Analyze)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	2					2	1		1
CO 2	3	2	1	2					2	1		1
CO 3	3	2	1	2					2	1		1
CO 4	3	2	1	2					2	1		1
CO 5	3	2	1	2					2	1		1

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Class work/ Assessment Viva-voce : 20 marks
Viva voce / test : 15 marks
Record : 5 marks

End Semester Examination Pattern

Experiment part : 70 marks
Viva voce : 30 marks

Guidelines for award of marks for the experiment part:

Preliminary work : 15 Marks
Implementing the work/Conducting the experiment : 25 Marks
Performance, result and inference : 30 Marks

KNOWLEDGE IS POWER

SYLLABUS

LIST OF EXPERIMENTS

Minimum **12** experiments are mandatory (Including study)

1	Study of taps, valves, pipe fittings, gauges, and plumbing tools to understand their function, design, and application in fluid systems.
2	Study of the hydraulic ram to understand its application in lifting water using minimal energy.
3	Performance test on Pelton wheel turbine
4	Performance test on Kaplan turbine
5	Best gate opening of Francis turbine
6	Performance test on Francis turbine
7	Performance test on a centrifugal pump
8	Performance test on a reciprocating pump
9	Performance test on a self-priming pump
10	Performance test on a gear pump
11	Measurement of metacentric height and radius of gyration in floating bodies
12	Calibration of a venturimeter to determine the coefficient of discharge
13	Calibration of a orifice meter to determine the coefficient of discharge
14	Calibration of a triangular or rectangular notch to determine the coefficient of discharge
15	Determination of Chezy's and Darcy's constants for pipe flow
16	Determination of Chezy's and Manning's coefficients for open channel flow
17	Determination of hydraulic coefficients of orifice under time for emptying method.

Reference Books

1. Yunus A. Cenegel, John M. Cimbala; Fluid Mechanics- Fundamentals and Applications, 4th ed., McGraw Hill, 2018.
2. Bansal R.K, A Textbook of Fluid Mechanics and Hydraulic Machines, 11th ed, Laxmi Publications, 2023.
3. Modi P.N and Seth S.M, Hydraulics and Fluid Mechanics Including Hydraulic Machines, Standard Book House, New Delhi, 22th Edition, 2019.
4. Graebel. W. P, Engineering Fluid Mechanics, Taylor & Francis, Indian Reprint, 2011.
5. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard; Introduction to Fluid Mechanics; John Wiley & Sons, 10th Edition, 2019.
6. Franzini. J.B, Finnemore E.J, Fluid Mechanics with Engineering Applications; McGraw Hill, 10th Edition, 2001.

MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 4

(MINOR)

SYLLABUS

B24MEM41	MECHANICS OF MACHINES	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course provides an extensive study of motion analysis in mechanical systems, covering concepts such as displacement, velocity, and acceleration. It explores the operational principles behind cams, gears, and gear trains. The course also covers topics like static force analysis of planar mechanisms, gyroscopic dynamics, and the evaluation and correction of unbalance in rotating and reciprocating systems, equipping students with the knowledge and skills to solve advanced mechanical challenges.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Make use of the principles in the formation of mechanisms and their kinematics to perform velocity and acceleration analysis. (Cognitive Knowledge Level: Apply)
CO 2	Apply different techniques to synthesize cam profiles for different types of motion. (Cognitive Knowledge Level: Apply)
CO 3	Make use of the basic concepts of toothed gearing and apply kinematic principles to evaluate gear trains (Cognitive Knowledge Level: Apply)
CO 4	Apply static force analysis techniques to different mechanisms and evaluate the effects of gyroscopic couples. (Cognitive Knowledge Level: Apply)
CO 5	Utilize different methods to determine the unbalance in rotating and reciprocating masses. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	1									2
CO 2	3	2	3									2
CO 3	3	2	2		2							2
CO 4	3	2	1	2								2
CO 5	3	2	3	2	2							2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

KNOWLEDGE IS POWER

SYLLABUS

MODULE 1 (9 hours)

Introduction to kinematics and mechanisms - Terminology and definitions, degree of freedom, Grashof's criterion, Mechanisms and inversions. Velocity and acceleration in mechanisms, Instantaneous centre of rotation, Kennedy theorem.

MODULE 2 (8 hours)

Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration. Graphical cam profile synthesis.

MODULE 3 (10 hours)

Gears – Classification- terminology of spur gears – law of gearing -tooth profiles- involute spur gears- contact ratio - interference - backlash - gear standardization –interchangeability. Gear trains - simple and compound gear trains - planetary gear trains.

MODULE 4 (9 hours)

Static force analysis- Analysis of four bar linkages and slider crank mechanism, graphical method, Principle of virtual work. Gyroscopic couples-spin, precession and applied gyroscopic couple vectors-effects on the stability of two wheelers, four wheelers and air crafts, application of gyroscopes.

MODULE 5 (9 hours)

Static balancing-dynamic balancing-balancing of several masses in the same plane-several masses in different planes-graphical and analytical method. Balancing of reciprocating masses -Single cylinder engine-multi cylinder engine.

Text Books

1. S. S. Rattan, "Theory of Machines'', Tata Mc Graw Hill, 2019.
2. Ballaney P. L., ''Theory of Machines and Mechanisms'', Khanna Publishers, 2018.

Reference Books

1. C. E. Wilson, P. Sadler, ''Kinematics and Dynamics of Machinery'', Pearson Education,2014.
2. D. H. Myskza, ''Machines and Mechanisms Applied Kinematic Analysis'', Pearson Education, 2015.
3. G. Erdman, G. N. Sandor, ''Mechanism Design: Analysis and synthesis'', Vol I & II, Prentice Hall of India, 2001.
4. Ghosh, A. K. Malik, ''Theory of Mechanisms and Machines'', Affiliated East West Press, 2015.
5. J. E. Shigley, J. J. Uicker, ''Theory of Machines and Mechanisms'', McGraw Hill, 2023.
6. Norton, ''Kinematics and Dynamics of Machinery'', Tata McGraw Hill, 2009.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**9**
1.1	Introduction to kinematics and mechanisms - Terminology and definitions.	1
1.2	Degree of freedom- Grashof's criterion.	2
1.3	Mechanisms and inversions.	2
1.4	Velocity and acceleration diagrams.	2
1.5	Instantaneous centre of rotation, Kennedy theorem.	2
	Module 2	**8**
2.1	Cams - classification of cam and followers.	2
2.2	Displacement diagrams, velocity and acceleration analysis of SHM.	2
2.3	Uniform velocity, uniform acceleration.	2
2.4	Graphical cam profile synthesis.	2
	Module 3	**10**
3.1	Gears – Classification- terminology of spur gears.	2
3.2	Law of gearing -Tooth profiles- involute spur gears.	2
3.3	Contact ratio - interference – backlash.	1
3.4	Gear standardization –interchangeability.	1
3.5	Gear trains - simple and compound gear trains.	2
3.6	Planetary gear trains.	2
	Module 4	**9**
4.1	Static force analysis- Analysis of four bar linkages and slider crank mechanism.	2
4.2	Graphical method.	2
4.3	Principle of virtual work.	1
4.4	Gyroscopic couples-spin, precession and applied gyroscopic couple vectors.	2
4.5	Effects on the stability of, Four wheelers, two wheelers and air crafts.	2
	Module 5	**9**
5.1	Static balancing-dynamic balancing.	1
5.2	Balancing of several masses in the same plane.	2
5.3	Several masses in different planes-graphical method.	2
5.4	Analytical method.	2
5.5	Balancing of reciprocating masses -Single cylinder engine, Multi cylinder engine.	2
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. What is the difference between a kinematic link and a kinematic pair?
2. Explain the inversions of a four-bar mechanism.
3. What is Grashof's criterion and how it determines the degree of freedom of a mechanism?
4. What are the different types of mechanism?

Course Outcome 2 (CO2):

1. What are the different types of cams and followers?
2. What is the significance of the dwell period in a cam profile?
3. What are the different methods of cam profile construction?
4. How can displacement diagrams be used in the analysis of cam motions?

Course Outcome 3 (CO3):

1. What are the different classifications of gears?
2. With a neat sketch explain the terminology of spur gears.
3. What is meant by the contact ratio in gears? Explain its importance in gear design.
4. What is interference in gears, and how can it be minimized during gear design?

Course Outcome 4 (CO4):

1. Perform the static force analysis of a slider-crank mechanism under various loading conditions.
2. Explain the principle of virtual work.
3. Explain gyroscopic effect.
4. How does the precession of a gyroscope affect the motion of a vehicle or aircraft?

Course Outcome 5 (CO5):

1. What is the difference between static and dynamic balancing?
2. Determine the magnitude and location of the balancing masses needed to balance the unbalanced masses rotating in different planes.
3. How can reciprocating masses be balanced in a single-cylinder engine?
4. How is dynamic balancing achieved in multi-cylinder configuration?

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

***Course Code:* B24MEM41**

***Course Name:* MECHANICS OF MACHINES**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. What do you mean by degree of freedom?
2. Explain Kennedy's theorem related to the instantaneous centres.
3. What are the different types of followers used in cam mechanisms?
4. What is meant by rise, dwell, and fall in cam-follower motion?
5. What do you mean by backlash in gears?
6. What are the different classifications of gear?
7. Explain the principal of virtual work.
8. How does gyroscope help in the guidance of ships?
9. Differentiate between static balancing and dynamic balancing.
10. What do you mean by primary and secondary unbalance in reciprocating engines?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. For a four-bar mechanism ABCD with the following dimensions, calculate the velocity of joint C and the angular velocities of links CD and BC, if the angular velocity of link AB is 10 rad/sec in the clockwise direction. The dimensions are: AB = 30 cm, BC = CD = 35 cm, AD (fixed) = 60 cm, and angle BAD = 60. Solve using the graphical method. (14 marks).

OR

12. a) Differentiate between a machine and structure. (4 marks)

b) What is meant by inversion of a mechanism? Describe with suitable sketches the inversions of a double slider- crank chain. (10 marks)

Module 2

13. A cam with 25mm minimum radius is rotating clockwise at 480 rpm to give the follower motion to a roller of 20mm diameter. Lift = 40mm, follower rises during 120^o of cam rotation, dwells for 45^o of cam rotation, follower to return during 150^o of cam rotation and the follower dwells for the remaining period. The rise and return of the follower take place with cycloidal motion. The line of stroke of the follower is offset by 10mm from the center of the cam. Construct the cam profile and determine the maximum velocity and acceleration during rise and return stroke. (14 marks)

OR

14. A disc cam profile is to be synthesized to provide simple harmonic motion (SHM) to a knife-edge offset follower during the outstroke of 50 mm. The cam's motion consists of the following: an ascent angle of 120°, dwell for 60°, a descent angle of 90°, and the follower dwells for the remaining cam rotation. The minimum radius of the cam is 50 mm. (14 marks)
    a. Draw the cam profile when the knife-edge follower is offset by 20 mm.
    b. Calculate the maximum velocity and acceleration during ascent and descent when the camshaft revolves at 240 rpm, and plot the velocity and acceleration diagrams.

Module 3

15. In a compound epicyclic gear train, as shown in the diagram, gears A, D, and E rotate freely on the axis P. The compound gears B and C rotate together on axis Q at the end of arm F. All gears have equal module, and the number of teeth on gears A, B, and C are 18, 45, and 21, respectively. Gears D and E are annular gears. Gear A rotates at 120 rpm counter-clockwise, and gear D rotates at 450 rpm clockwise. Determine the speed and direction of the arm F and gear E.

(14 marks)

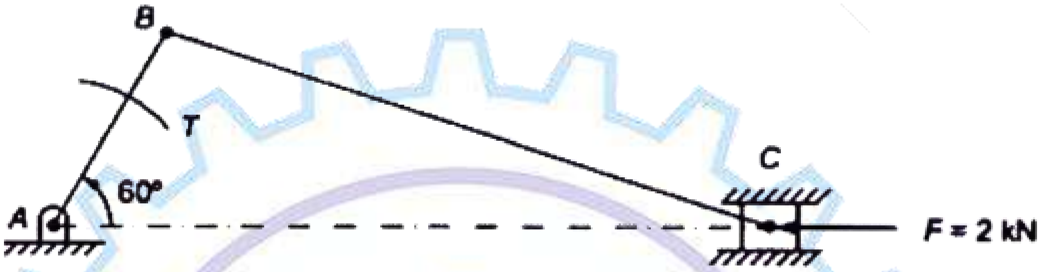
OR

16. a) Two 20° involute spur gears mesh externally and give a velocity ratio of 3. The module is 3mm and the addendum is equal to 1.1 module. If the pinion rotates at 120 rpm, determine the minimum number of teeth on each wheel to avoid interference and the contact ratio. (8 marks)

    b) Explain the functioning of a reverted gear train? Derive its velocity ratio. (6 marks)

Module 4

17. In the slider-crank mechanism shown in figure, where the force applied to the slider is 2 kN, and the link dimensions are as follows: AB = 80 mm, BC = 240 mm, and the crank angle θ=60∘. Determine the forces acting on the various links and the driving torque T. (14 marks)



OR

18. An airplane flying at 240 km/h turns left and completes a quarter cycle with a radius of 60 m. The mass of the engine and propeller is 450 kg, with a radius of gyration of 320 mm. The engine speed is 2000 rpm in the clockwise direction when viewed from the rear. Calculate the gyroscopic couple acting on the aircraft. (14 marks)

Module 5

19. Four masses m1, m2, m3, and m4 have values of 200 kg, 300 kg, 240 kg, and 260 kg, respectively. The corresponding radii of rotation are 0.2 m, 0.5 m, 0.25 m, and 0.3 m, respectively, with the angles between successive masses being 45°, 75°, and 135°. Determine the position and magnitude of the balancing mass required, assuming its radius of rotation is 0.2 m. (14 marks)

OR

20. An inside-cylinder locomotive has its cylinder centerlines 0.7 m apart and a stroke of 0.6 m. The rotating mass per cylinder is equivalent to 150 kg at the crank pin, and the reciprocating mass per cylinder is 180 kg. The wheel centerlines are 1.5 m apart, and the cranks are at right angles. The entire rotating and half of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Calculate the fluctuation in rail pressure under one wheel, the variation of tractive effort, and the magnitude of the swaying couple at a crank speed of 300 rpm. (14 marks)

KNOWLEDGE IS POWER

B24MEM42	THERMODYNAMICS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

Engineering thermodynamics explores the principles of energy, its transformations, and its interactions with matter. This course delves into fundamental concepts such as heat, work, and the laws of thermodynamics, which are essential for designing efficient systems, including engines and power plants. A strong foundation in thermodynamics is crucial for tackling challenges related to energy production, consumption, and environmental sustainability, making it a key discipline in advancing modern engineering solutions.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Make use of Zeroth law of Thermodynamics to define temperature and to apply its basic principles to thermal systems (Cognitive Knowledge Level: Apply)
CO 2	Apply first law of thermodynamics to analyse energy interactions in non-flow processes (Cognitive Knowledge Level: Apply)
CO 3	Apply first law of thermodynamics to analyse energy interactions and mass balance in flow (Cognitive Knowledge Level: Apply)
CO 4	Understand second law to various processes to appreciate directionality of processes (Cognitive Knowledge Level: Understand)
CO 5	Explain various power generating thermodynamic cycles. (Cognitive Knowledge Level: Understand)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	2		1	1		1			1
CO 2	3	2	1	2		1	1		1			1
CO 3	3	2	1	2		1	1		1			1
CO 4	3	2	1	2		1	1		1			1
CO 5	3	2	1	2					1			1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	40	40	40
Apply	50	50	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

MODULE 1 (8 hours)

Role of Thermodynamics and it's applications in Engineering and Science –Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.

MODULE 2 (10 hours)

First law of thermodynamics for Non-Flow process: Forms of Energy, Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity. First law of Thermodynamics - First law applied to Non flow Process

MODULE 3 (8 hours)

First law of thermodynamics for Flow process: examples of control volume analysis, Flow work, Enthalpy- specific heats, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Limitations of the First Law.

MODULE 4 (10 hours)

Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale.

MODULE 5 (9 hours)

Review of Power Generation Cycles- Ideal Rankine Cycle -Effect of Temperature and Pressure on Rankine Cycle, Ideal Brayton Cycle, Turbine work, Compressor work and Efficiency. Review of Vapour Compression Refrigeration cycle-Basic schematic, components

Text Books

1. Yunus Cengel, et al , "Thermodynamics: An Engineering Engineering Approach", McGraw Hill, 9th Edition, 2019

Reference Books

1. Moran J., Shapiro N. M., "Fundamentals of Engineering Thermodynamics", Wiley, 9th Edition, 2018
2. R. E. Sonntag and C. Borgnakke, "Fundamentals of Thermodynamics", Wiley, 8th Edition, 2012
3. P. K. Nag, "Engineering Thermodynamics", McGraw Hill, 6th Edition, 2017

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**8**
1.1	Role of Thermodynamics and it's applications in Engineering and Science	1
1.2	Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe	2
1.3	Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi-static Process, State, Point and Path function.	2
1.4	Zeroth Law of Thermodynamics, Measurement of Temperature,	1
1.5	Reference Points, Temperature Scales.	2
	Module 2	**10**
2.1	First law of thermodynamics for non-flow processes	2
2.2	Forms of Energy	1
2.3	Work - Pdv work and other types of work transfer, free expansion work	2
2.4	heat and heat capacity	1
2.5	First law of Thermodynamics	2
2.6	First law applied to Non flow Process-Problems	2
	Module 3	**8**
3.1	Flow processes-examples of control volume analysis	2
3.2	Concept of Flow work, Enthalpy	2
3.3	Specific heats, First law applied to Flow Process	1
3.4	Mass and Energy balance in simple steady flow process.	1
3.5	Applications of SFEE, Limitations of the First Law	2
	Module 4	**10**
4.1	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin-Planck and Clausius Statements	1
4.2	Equivalence of two statements, Reversibility	2
4.3	Irreversible Process, Causes of Irreversibility	1
4.4	Carnot theorem	1
4.5	Carnot Cycle-Significance of Carnot efficiency	2
4.6	Carnot theorem corollaries	1
4.7	Absolute Thermodynamic Temperature scale.	2
	Module 5	**9**
5.1	Review of Power Generation Cycles	1
5.2	Ideal Rankine Cycle	1
5.3	Effect of Temperature and Pressure on Rankine Cycle	2
5.4	Ideal Brayton Cycle, Turbine work, Compressor work and Efficiency.	2
5.5	Review of Vapour Compression Refrigeration cycle	2
5.6	Basic schematic, Functions of basic components, COP	1
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Discuss the different types of systems.
2. Differentiate between Intensive and extensive properties
3. Explain various temperature scales used in engineering

Course Outcome 2 (CO2):

1. State first law of thermodynamics for non flow process.
2. A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston –cylinder device. The air is now compressed to a final pressure of 600 kPa . During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process.
3. What are the limitations of first law?

Course Outcome 3 (CO3):

1. Carbon dioxide enters an adiabatic nozzle steadily at 1 MPa and 500°C with a mass flow rate of 600 kg/hr and leaves at 100 kPa and 450 m/s. The inlet area of the nozzle is 40 cm2. Determine (a)the inlet velocity and (b) the exit temperature
2. Derive Steady flow energy equation.
3. Analyse heat transfer in heat exchanger using Steady flow energy equation.

Course Outcome 4 (CO4):

1. State the second law of thermodynamics.
2. Prove equivalence of second law statements.
3. State and explain the significance of Carnot theorem.

Course Outcome 5 (CO5):

1. Plot the T-s diagram of Rankine Cycle. Explain the processes using a schematic.
2. Explain the working of a vapor compression refrigeration cycle.
3. How can the efficiency of a Rankine cycle be improved?

KNOWLEDGE IS POWER

MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEM42**

Course Name: **THERMODYNAMICS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Define thermodynamics. List a few of its applications
2. Differentiate between intensive and extensive properties.
3. Differentiate between heat and work.
4. State the first law of thermodynamics for a closed system
5. Define internal energy and enthalpy.
6. Apply the SFEE across a nozzle.
7. State second law of thermodynamics.
8. An inventor claims to have developed an engine that delivers 26 kJ of work using 82 kJ of heat while operating between temperatures 120°C and 30°C. Is his claim valid ? Give the reason for your answer.
9. How can you estimate the pump work in Rankine cycle?
10. Define COP of a refrigerator.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. a) What is meant by thermodynamic equilibrium? What are the essential conditions for a system to be in thermodynamic equilibrium? (7 marks)

    b) Express the temperature of 91 ^{o}C in (i) Fahrenheit (ii) Kelvin (iii) Rankine. (7 marks)

OR

12. a) Explain macroscopic and microscopic approach to thermodynamics. (7 marks)

b) With the aid of a suitable diagram, explain the working of constant volume gas thermometer. (7 marks)

Module 2

13. A mass of 2.4 kg of air at 150 kPa and 12 ^{o}C is contained in a gas – tight, frictionless piston –cylinder device. The air is now compressed to a final pressure of 600 kPa. During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process (14 marks)

OR

14. Explain various forms of energy. What are the different forms in which internal energy is stored. (14 marks)

Module 3

15. State the general energy balance equation for an unsteady flow system and from it, derive the energy balance equation for a bottle filling process, stating all assumptions. (14 marks)

OR

16. A turbine operates under steady flow conditions, receiving steam at the following conditions: pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3m. The steam leaves the turbine at the following conditions: pressure 20 kPa, enthalpy 25kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42kg/s, what is the power output of the turbine in kW? (14 marks)

Module 4

17. State the Kelvin-Planck and Clausisus statements of the second law of thermodynamics and prove their equivalence. (14 marks)

OR

18. State and prove corollaries of Carnot theorem (14 marks)

Module 5

19. Explain Rankine cycle with neat schematics. Explain the effect of operating parameters on cycle efficiency. (14 marks)

OR

20. Explain vapor compression refrigeration with a neat labelled sketch. Derive an expression for COP of a vapor compression cycle. (14 marks)

B24MEM43	MANUFACTURING PROCESS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course explores the techniques and methods used to convert raw materials into finished products. It covers a diverse array of manufacturing processes, such as casting, machining, welding, and additive manufacturing, all of which play a crucial role in industries like automotive, aerospace, electronics, and consumer goods. Mastering these processes is key to designing efficient production systems, maintaining product quality, and minimizing costs. Students will gain a deep understanding of the principles, tools, and technologies that power modern manufacturing, equipping them for careers in engineering, production management, and industrial design.

Prerequisite

Nil

Course Outcomes

After the completion of the course the student will be able to:

CO 1	Explain the basics and various types of casting. (Cognitive Knowledge Level: Understand)
CO 2	Understand the fundamentals and mechanisms associated with powder metallurgy (Cognitive Knowledge Level: Understand)
CO 3	Compare various welding techniques. (Cognitive Knowledge Level: Understand)
CO 4	Apply the basics of metal forming and shaping processes (Cognitive Knowledge Level: Apply)
CO 5	Outline the fundamentals of photolithography. (Cognitive Knowledge Level: Understand)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1	1					2
CO 2	2	1			1				1			2
CO 3	2		1									2
CO 4	2		1		1							2
CO 5	2	1		2	2							2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	40	20	30
Understand	60	50	40
Apply		30	30
Analyze			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/ Quiz/ Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

KNOWLEDGE IS POWER

SYLLABUS

MODULE 1 (10 hours)

Overview of manufacturing processes and their importance in engineering - Classification of manufacturing processes: primary, secondary, and tertiary processes - Fundamentals of casting processes: patterns, molds, melting, pouring, and solidification - Metal casting:-sand casting:-shell mold casting, evaporative pattern casting, investment casting, permanent mold casting, vacuum casting, slush casting, pressure casting, die casting, centrifugal casting, squeeze casting - Defects in casting and their remedies.

MODULE 2 (9 hours)

Powder metallurgy - powder production methods: atomization and electrolysis - powder characteristics: size and shape, blending, mixing: types of devises used, compaction of metal powders: pressing and rolling – different types - sintering fundamentals and mechanisms - infiltration and impregnation, advantages, dis advantages and applications

MODULE 3 (9 hours)

Welding - arc welding - consumable electrodes; heat affected zone; quality; case study and weld ability of metals – non-consumable electrodes; electron and laser beam welding; heat affected zone; power density - weld quality; case study; application - Brazing:- filler metals, fluxes, joint strength; brazing methods, applications - Soldering: - solders and fluxes - soldering methods - solder ability, case study, applications.

MODULE 4 (9 hours)

Fundamentals of metal forming: plastic deformation and yield criteria - Forging: open-die, closed-die, and impression-die forging processes - Rolling: types of rolling mills, rolling defects, and applications - Extrusion and drawing processes: principles, types, and applications - Sheet metal forming processes: bending, stretching, shearing, and deep drawing.

MODULE 5 (8 hours)

Photo lithography - different lithography methods - Etching, wet etching, dry etching-diffusion and Ion implantation metallization and testing - wire bonding and packing - yield and reliability - fabrication of micro electro mechanical devices

Text Book

1. Serope Kalpakjian, Steven R. Schmid - Manufacturing Engineering and Technology, 7th Edn. Pearson.

Reference Books

1. P. N. Rao, Manufacturing Technology, McGraw Hill.
2. G. Boothroyd, Fundamentals of Manufacturing Processes, CRC Press.
3. J. A. Schey, Introduction to Manufacturing Processes, McGraw Hill.

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COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Lectures/ Tutorial hours
	Module1	**10**
1.1	Overview of manufacturing processes and their importance in engineering	2
1.2	Classification of manufacturing processes	1
1.3	Fundamentals of casting processes	1
1.4	Metal casting types – sand casting, shell mold casting, evaporative pattern casting, investment casting, permanent mold casting	1
1.5	Investment casting, permanent mold casting	1
1.6	Vacuum casting, slush casting, pressure casting	1
1.7	Die casting, centrifugal casting, squeeze casting	1
1.8	Casting defects and Remedies	2
	Module 2	**9**
2.1	Introduction to powder metallurgy	2
2.2	Powder production methods	1
2.3	Powder characteristics - size and shape	2
2.4	Blending, mixing and compaction of metal powders	2
2.5	Sintering fundamentals and mechanisms	1
2.6	Infiltration and impregnation, advantages, disadvantages and applications	1
	Module 3	**9**
3.1	Introduction to welding and classifications	2
3.2	Arc welding – consumable electrodes	1
3.3	HAZ and weldability of metals with case study	2
3.4	Arc welding – non-consumable electrodes	1
3.5	Electron beam and laser beam welding	1
3.6	Soldering & brazing – case study and applications	2
	Module 4	**9**
4.1	Fundamentals of metal forming	1
4.2	Plastic deformation and yield criteria	1
4.3	Fundamentals of forging and classifications	2
4.4	Rolling - types, defects and applications	2
4.5	Extrusion and drawing processes - principles, types, and applications	1
4.6	Sheet metal forming processes	1
4.7	Bending, stretching, shearing, and deep drawing	1
	Module 5	**8**
5.1	Fundamentals of photo lithography	1
5.2	Different lithography methods – Etching: wet etching, dry etching	2
5.3	Diffusion and Ion implantation metallization and testing	1
5.4	Wire bonding and packing	1
5.5	Yield and reliability	1
5.6	Fabrication of micro electro mechanical devices	2
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. What is the importance of allowance in patterns
2. List out various types of casting defects.

Course Outcome 2 (CO2):

1. What are the factors affecting the sintering process in powder metallurgy?
2. How do surface preparations affect the strength of the joint in the welding processes

Course Outcome 3 (CO3):

1. Explain why vacuum is required in electron beam welding
2. What are the different types of lasers

Course Outcome 4 (CO4):

1. What are the defects in the forging process
2. List out the main steps involved in the lithography process

Course Outcome 5 (CO5):

1. What is the purpose of prebaking and post baking in lithography
2. What are the types of metallization?

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MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEM43**

Course Name: **MANUFACTURING PROCESS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Identify and give details on the casting process used for the manufacturing of a cast iron pipe.
2. Differentiate between the brazing and the soldering processes.
3. Give any two limitations of the hot extrusion process.
4. Differentiate between the dry etching and the wet etching processes.
5. Give any two functions of the flux used in the arc welding process.
6. Why does the powder metallurgy process used for the making of the components which contains tungsten or platinum as elements.
7. Name and explain the casting process used for the manufacture of intricate shaped components.
8. Give any two advantages of the Laser Beam Welding process.
9. What is the major drawback of the electron beam lithography process.
10. Why spanners are made by forging process?

PART B

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. a) What is the function of a pattern? Write short notes on any three types of patterns. (8 Marks)

b) Write down the method and application of slush casting process. (6 Marks)

OR

12. a) Explain the hot chamber die casting process with a neat figure. (8 Marks)

b) Explain various casting defects with neat sketches. (6 Marks)

Module 2

13. a) Explain the Plasma Arc Welding process with a neat sketch. (8 Marks)
    b) Explain the terms 'weldability' and 'heat affected zone'. (6 Marks)

OR

14. a) Explain the various steps involved in the making of components by using the powder metallurgy process. (8 Marks)
    b) Give the various advantages of powder metallurgy process. (6 Marks)

Module 3

15. a) Explain the submerged arc welding process with a neat sketch. (8 Marks)
    b) Describe the principle of arc welding process. (6 Marks)

OR

16. a) Write short notes on the brazing process. Name the filler material and the flux used in the brazing process. (8 Marks)
    b) Describe the soldering process and its applications. (6 Marks)

Module 4

17. a) Explain the direct extrusion process with a neat figure. (8 Marks)
    b) Compare the cold extrusion process and the hot extrusion process. (6 Marks)

OR

18. a) Explain the wire drawing process with a neat figure. (8 Marks)
    b) Explain the principle and the method of the photolithography technique.(6 Marks)

Module 5

19. a) Describe the ion implantation process with a neat figure. (8 Marks)
    b) Explain the bulk and the surface micromachining processes. (6 Marks)

OR

20. a) Describe the electron beam lithography process. (6 Marks)
    b) Explain the wire bonding and packaging process. (8 Marks)

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MAR ATHANASIUS COLLEGE OF ENGINEERING

Government Aided, Autonomous Institution
Kothamangalam, Kerala, India

B.TECH MECHANICAL ENGINEERING

SEMESTER 4

(HONOURS)

SYLLABUS

<table>
<tr><td rowspan="2">B24MEH41</td><td rowspan="2">DESIGN OF HYDRAULIC AND PNEUMATIC EQUIPMENTS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>3</td><td>4</td><td>2024</td></tr>
</table>

Preamble

This course provides students with a comprehensive understanding of fluid power principles, focusing on the operation, and maintenance of hydraulic and pneumatic systems. Students will explore the fundamental concepts of fluid mechanics, pump classifications, actuators, control valves, and circuit design. The course also emphasizes troubleshooting techniques and industrial applications, enabling students to diagnose faults and optimize system performance. By the end of the course, students will be equipped to apply fluid power technology in various industrial applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Explain the fundamental principles of fluid power and its applications in hydraulic systems. (Cognitive Knowledge Level: Understand)
CO 2	Outline the construction, working, and selection of hydraulic actuators and control components used in industrial applications. (Cognitive Knowledge Level: Understand)
CO 3	Explain different hydraulic circuits and systems used in industrial processes and their functional significance. (Cognitive Knowledge Level: Understand)
CO 4	Model pneumatic and electro-pneumatic circuits for automation and industrial control. (Cognitive Knowledge Level: Apply)
CO 5	Develop skills in troubleshooting, diagnosing faults, and optimizing the performance of hydraulic and pneumatic systems. (Cognitive Knowledge Level: Apply)

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2									1
CO 2	3	3	2									1
CO 3	3	3	2									1
CO 4	3	3	3									1
CO 5	3	3	3	3	2							1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	30	10	10
Understand	70	50	50
Apply		40	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

Module 1 (6 hours)

Fluid power principles and hydraulic pumps: Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law, Sources of Hydraulic power, Pump Classification – Construction, Working, Design, Advantages, and Disadvantages.

Module 2 (9 hours)

Hydraulic actuators and control components: Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves

Module 3 (11 hours)

Hydraulic circuits and systems: accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Mechanical hydraulic servo systems.

Module 4 (9 hours)

Pneumatic and electro pneumatic systems: Properties of air – Perfect Gas Laws – Compressor– Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System.

Module 5 (10 hours)

Trouble shooting and applications: Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools.

Text Books

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

References

1. Shanmugasundaram K., "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McGraw Hill, 2001

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COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module1	**6**
1.1	Introduction to Fluid power, Advantages and Applications	1
1.2	Fluid power systems, Types of fluids	1
1.3	Properties of fluids and selection, Basics of Hydraulics, Pascal's Law	1
1.4	Sources of Hydraulic power, Pump Classification – Construction	2
1.5	Working, Design, Advantages, Disadvantages	1
	Module 2	**9**
2.1	Hydraulic Actuators: Cylinders, Types and construction, Application	2
2.2	Hydraulic cushioning	1
2.3	Hydraulic motors, Control Components : Direction Control	2
2.4	Flow control Valve, Pressure control valves, Types, Construction and Operation	2
2.5	Servo and Proportional valves, Servo and Proportional valves	2
	Module 3	**11**
3.1	Accumulators, Intensifiers	1
3.2	Industrial hydraulic circuits	2
3.3	Regenerative pump, Pump Unloading	1
3.4	Double-Pump, Pressure Intensifier	2
	Air-over oil, Sequence	1
	Reciprocation & Synchronization	1
	Fail-Safe, Speed Control	1
	Hydrostatic transmission, Mechanical hydraulic servo systems.	2
	Module 4	**9**
4.1	Properties of air, Perfect Gas Laws	1
4.2	Compressor – Filters, Regulator	2
4.3	Lubricator, Muffler	1
4.4	Air control Valves, Quick Exhaust Valves	2
4.4	Pneumatic actuators, Design of Pneumatic circuit, Cascade method	2
4.5	Electro Pneumatic System	1
	Module 5	**10**
5.1	Installation of Pneumatic systems, Selection, Maintenance	2
5.2	Trouble Shooting and Remedies in Hydraulic and Pneumatic systems	2
5.3	Design of hydraulic circuits for Drilling	1
5.4	Design of hydraulic circuits for Surface Grinding	1
5.5	Press and Forklift applications	1
5.6	Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools.	3
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Write short notes about types of fluids used in the fluid power systems
2. Explain the working principle of external Gear pump and Internal Gear pump with neat sketch.

Course Outcome 2 (CO2):

1. How do you select hydraulic pipes for a hydraulic system?
2. Mention the significance of telescopic cylinder with industrial application

Course Outcome 3 (CO3):

1. Discuss the construction and working of a Mechanical hydraulic servo system with a diagram
2. Explain the working principle of following (1) 3/2 Way Valve (2) 4/2 way valve (3) 4/3 way valve

Course Outcome 4 (CO4):

1. Describe pneumatic Actuators and explain the types of linear Actuators
2. Explain the various approaches for entering the program into the PLC

Course Outcome 5 (CO5):

1. Explain in detail about how the failure and troubleshooting is carried out in hydraulic system
2. Describe the basic concepts of low-cost automation with suitable example

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MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEH41**

Course Name: **DESIGN OF HYDRAULIC AND PNEUMATIC EQUIPMENTS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. What are the advantages of fluid power systems over mechanical and electrical systems?
2. State Pascal's Law and explain its significance in hydraulic systems.
3. Differentiate between hydraulic cylinders and hydraulic motors
4. What are the different types of hydraulic directional control valves?
5. How does a regenerative hydraulic circuit improve efficiency?
6. What is a fail-safe circuit, and where is it used?
7. Explain the function of a filter-regulator-lubricator (FRL) unit in a pneumatic system
8. How does an electro-pneumatic system differ from a conventional pneumatic system?
9. What are the common causes of hydraulic system failures?
10. How do you diagnose and fix a pressure drop in a hydraulic system?

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. What are the types of piston pump? Explain the working principle of radial piston pumps with neat sketch?

OR

12. Explain Pascal's Law and its significance in hydraulic systems. How does Pascal's Law contribute to the efficiency and functionality of hydraulic systems? Provide real-world

examples of how this law is applied in fluid power systems.

Module 2

13. Explain the working principles and applications of hydraulic motors in fluid power systems. How do hydraulic motors differ from hydraulic cylinders, and what are the specific advantages they offer in motion control?

OR

14. Examine the various types of control valves used in hydraulic systems. Discuss their construction, operation, and the role they play in regulating the performance and safety of hydraulic systems.

Module 3

15. Discuss the function and working principle of accumulators and intensifiers in hydraulic circuits. How do these components enhance the efficiency and performance of hydraulic systems, and what are their specific applications in industrial settings?

OR

16. Examine the different types of industrial hydraulic circuits, such as regenerative, pump unloading, and double-pump circuits. Explain the principles behind each circuit type and their respective advantages in optimizing system performance and reducing energy consumption.

Module 4

17. Discuss the role of key components in a pneumatic system, including compressors, filters, regulators, lubricators, and mufflers. How does each component contribute to the overall efficiency and reliability of the system, and what considerations should be made during their selection and maintenance?

OR

18. Examine the design of pneumatic circuits using the Cascade method and the integration of electro-pneumatic systems. How does the Cascade method aid in designing efficient pneumatic circuits, and what advantages do electro-pneumatic systems provide in terms of automation and control in industrial processes?

Module 5

19. Explain the key factors involved in the selection, installation, and maintenance of hydraulic and pneumatic systems. Discuss their importance in ensuring system efficiency and reliability.

OR

20. Compare and contrast hydraulic and pneumatic systems in terms of design, operation, troubleshooting, and applications. Provide examples of industrial uses where each system is preferred.

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B24MEH42	ADVANCED FLUID MECHANICS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course explores the fundamental principles and methods of both compressible and incompressible flows, with a strong focus on applying core fluid mechanics concepts to real-world problems. By the end of the course, students will have a solid understanding of flow dynamics and the skills to analyze various fluid mechanical systems effectively.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Model physical fluid dynamics systems using the application of proper governing equations with suitable boundary conditions. (Cognitive Knowledge Level: Apply)
CO 2	Apply conservation equations to analytically solve simple fluid dynamics problems on the broad area of potential flows, vortex flows and laminar flows. (Cognitive Knowledge Level: Apply)
CO 3	Understand boundary layer theory and instability theory and apply these in real fluid flow systems. (Cognitive Knowledge Level: Apply)
CO 4	Categorize compressible flows and apply suitable governing equations for isentropic flows. (Cognitive Knowledge Level: Apply)
CO 5	Examine shock waves and its consequences in physical systems. (Cognitive Knowledge Level: Apply)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	2	1	3	1						1
CO 2	1		3	1	2	1						1
CO 3	2	2	2	1	1	2						1
CO 4	1		1		3	1						1
CO 5	3		3	2	2	1						1

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

SYLLABUS

Module 1 (10 hours)

A brief review of some preliminary concepts of Fluid Mechanics.

Fluid Kinematics: Lagrangian and Eulerian Approach- Acceleration of fluid flows- Reynolds Transport Theorem. Linear and angular Deformation-Concept of Vorticity, Potential Function and Stream function Governing Equations: Derivation of the general form of conservation of mass- Navier Stokes Equation- Energy Equation in differential and integral forms - Control volume analysis.

Module 2 (10 hours)

Vorticity Dynamics: Vortex lines and tubes, Role of viscosity in rotational and irrotational vortices- Kelvin's circulation theorem-Interaction of vortices.

Irrotational Flow Theory: Application of complex variables- Source, Sink, Doublet- Flow at a wall angle- Flow past a half body- Flow past a circular cylinder with circulation- Forces on 2D body.

Exact Solutions of N-S equations: Steady flow in pipes. Steady flow between parallel plates and concentric cylinders- Axi-symmetric flows; Impulsively started plates: Similarity solutions.

Module 3 (9 hours)

Boundary Layer Theory: Boundary Layer approximations- Measures of boundary layer thickness- Blasius Solution- Momentum Integral Equation- effect of pressure gradient- Separation- Flow past a circular cylinder and sphere- Dynamics of sports balls.

Flow Instabilities (Theory only): Introduction- Method of normal modes- Thermal instability- K-H instability.

Module 4 (8 hours)

Introduction to Compressible flows- Speed of Sound- Basic equation for 1 D flow.

Isentropic flow with variable area: Stagnation and Critical conditions, Mass flow rate, Geometric chocking, Isentropic flow through C-D nozzle.

Fanno flow: Adiabatic flow in constant area duct with friction, Fanno line, Friction choking and its consequences.

Module 5 (8 hours)

Rayleigh flow: Frictionless flow in constant area duct with heat transfer, Rayleigh line, Thermal choking and its consequences.

Standing normal shocks-– Fundamental relations-R-H equations- Stationary normal shock waves in C-D Nozzles; Oblique Shocks: Fundamental relations, property relationships, θ-β-M diagram. Shock Reflection and Intersections- shock tube.

References

1. Pijush K. Kundu, and Ira M. Cohen. "Fluid Mechanics". 4th ed. Academic Press, 2008.

2. James John & Theo Keith, "Gas Dynamics", Pearson Education, 2006.
3. White F. M., "Viscous Fluid Flow", Mc Graw Hill Pub., 2006
4. Schlichting, H., and K. Gersten. "Boundary Layer Theory". Springer, 2000.
5. John D Anderson, "Modern Compressible Flow", McGraw Hill, 2003
6. Shapiro A. H., "The Dynamics and Thermodynamics of Compressible Flow; Vol 1", 1953.
7. Annual Review of Fluid Mechanics.

COURSE CONTENTS AND LECTURE SCHEDULE

Sl. No	Topic	No. of Lecture/ Tutorial hours
Module 1		**(10 Hours)**
1.1	A brief review of some preliminary concepts of Fluid Mechanics	2
1.2	Lagrangian and Eulerian Approach- Acceleration of fluid flows- Stream line, Path line and Streak line	1
1.3	Fluid deformation, Reynolds Transport Theorem	1
1.4	Concept of Vorticity, Potential Function, and Stream Function	1
1.5	Conservation of mass	1
1.6	Conservation of momentum, Navier- Stokes equation	2
1.7	Conservation of energy; Control volume Analysis-Numerical Problems	2
Module 2		**(10 Hours)**
2.1	Vorticity Dynamics: Vortex lines and tubes, Role of viscosity in rotational and irrotational vortices	2
2.2	Kelvin's circulation theorem-Interaction of vortices	1
2.3	Irrotational Flow Theory: Application of complex variables	1
2.4	Source, Sink, Doublet- Flow at a wall angle	1
2.5	Flow past a circular cylinder with circulation- Forces on 2D body	1
2.6	Exact Solutions of N-S equations: Plane Couette flow and Poiseuille flow-; Hagen -Poiseuille flow	2
2.7	Exact Solutions of N-S equations: Steady flow between concentric cylinders, axisymmetric flows	1
2.8	Impulsively started plates: Similarity solutions; Numerical problems	1
Module 3		**(9 Hours)**
3.1	Boundary Layer Approximations- Measures of boundary layer thickness- displacement and momentum thickness	2
3.2	Blasius Solution, Falkner Skan Solution	2
3.3	Momentum Integral equations, Effect of Pressure gradient	1
3.4	Separation, Sport ball dynamics; Numerical Problems	1
3.5	Theory of Instability: method of normal modes, Orr-Sommerfield equation (Theory only)	2
3.6	Types of Instability: Benard Cells, K-H instability	1

Module 4		**(8 Hours)**
4.1	Introduction to Compressible flows- Speed of Sound- Basic equation for 1 D flow	2
4.2	Stagnation and static properties, Area-Velocity relationship in	2
4.3	Nozzles: mass flow rate, compressible flows in C-D nozzles Geometric choking.	2
4.4	Fanno flow: Effect of friction in constant area ducts- property relationships; Friction choking	2
Module 5		**(8 Hours)**
5.1	Frictionless flow in constant area duct with heat transfer, Rayleigh line, Thermal chocking and its consequences	2
5.2	Standing normal shocks-– Fundamental relations-R-H equations- Stationary normal shock waves in C-D Nozzles; Numerical problems	2
5.3	Oblique Shocks: Fundamental relations, θ-β-M diagram.	2
5.4	Shock Reflection and Intersections- Shock tube	2

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. What is the difference between stream function and velocity potential? Explain their significance in fluid flow analysis.
2. Explain the concept of material acceleration in the Eulerian description of fluid motion.

Course Outcome 2 (CO2):

1. What is Kelvin's circulation theorem, and what does it imply for inviscid flows?
2. Explain the significance of a source, sink, and doublet in potential flow theory.

Course Outcome 3 (CO3):

1. What is boundary layer separation, and how does it affect drag on a body?
2. Define momentum thickness and explain its significance in boundary layer theory.

Course Outcome 4 (CO4):

1. Explain the Fanno line and its representation on an h-s (enthalpy-entropy) diagram.
2. What is the sonic condition in a compressible flow, and how is it related to Mach number?

Course Outcome 5 (CO5):

1. What is a Rayleigh flow, and how does heat addition affect Mach number?
2. How does pressure change across a normal shock wave, and why does it happen?

MODEL QUESTION PAPER

QP CODE: Pages: 3

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURTH SEMESTER B TECH DEGREE EXAMINATION, DECEMBER 2025

Course Code: **B24MEH42**

Course Name: **ADVANCED FLUID MECHANICS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. Differentiate between the Lagrangian and Eulerian approaches in fluid mechanics with an example.
2. Derive the differential form of the mass conservation equation for an incompressible flow.
3. State Kelvin's circulation theorem and explain its significance in vortex dynamics.
4. Define a doublet and describe its role in the flow past a circular cylinder.
5. Explain the concept of boundary layer thickness and its different measures.
6. What is the Blasius solution, and how does it apply to boundary layer flow over a flat plate?
7. Derive an expression for the speed of sound in an ideal gas.
8. Explain the concept of friction choking in Fanno flow and its effect on flow properties.
9. What is thermal choking in Rayleigh flow, and how does it affect the flow?
10. Define a normal shock wave and explain how it affects pressure, temperature, and velocity.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. The velocity field in a flow field is given by $\bar{V} = \mathbf{33}xy^2\,\hat{\imath} + \mathbf{22}x\boldsymbol{j} + (\mathbf{22}zy + \mathbf{33}t)\hat{k}$. Find the magnitude and directions of (i) translational velocity, (ii) Rotational Velocity and (iii) vorticity of the fluid element at position (*1*,*2*,*1*) and time *t* =*3*. (14)

OR

12. Write down the general form of the Navier-Stokes equation for a three-dimensional unsteady viscous compressible flow in a gravitational field. Simplify the equation for steady incompressible irrotational flows. (14)

Module 2

13. Oil flows between two parallel plates, one of which is at rest and the other moves with a velocity *U*.

    a. If the pressure is decreasing in the flow direction at a rate of 10 Pa/m, the dynamic viscosity is 0.05 kg/m s, the spacing of the horizontal plate is 0.04 m and the volumetric flow (Q) per unit width is 0.03 m^2/s, what is the velocity *U*? (10)

    b. Calculate *U* if the pressure is increasing at a rate of 5 Pa/m, in the direction of flow. (4)

OR

14. Derive the velocity potential ϕ and stream function ψ for a doublet placed at the origin in a uniform flow of velocity U in the x-direction. (14)

Module 3

15. Water of kinematic viscosity $\upsilon = 1 \times 10^{-6}\ m^2/s$ is flowing steadily over a smooth flat plate at zero angle of attack with a velocity 1.6 m/s. The length of the plate is 0.3 m. Calculate (a) the thickness of the boundary layer at 15 cm from the leading edge. (b) the rate of growth of the boundary layer at 15 cm from the leading edge of the plate. Assume a parabolic velocity profile. (14)

OR

16. Explain how bowlers employ separation phenomena in a cricket game and how trajectories of sports balls are determined by boundary layer separation. How the same separation phenomena are detrimental in rocket propulsion systems? (14)

Module 4

17. Compressed air is discharged through the converging nozzle as shown in figure 2. The tank pressure is 500 kPa and local atmospheric pressure is 101 kPa. The inlet area of the nozzle is 100 cm^2; the exit area is 34 cm^2. Find the force of the air on the nozzle, assuming the air to behave as a perfect gas with constant γ=1.4. Take the temperature in the tank to be 300 K. You may assume that the nozzle is choked and isentropic flow. (14)

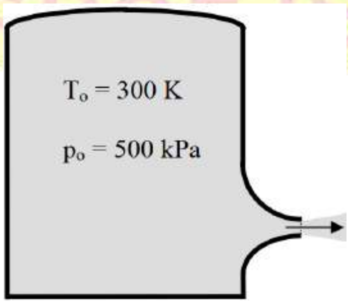


Figure 2

OR

18. Derive the governing equations for adiabatic flow in a constant-area duct with friction using the principles of conservation of mass, momentum, and energy. Discuss the significance of the Fanno line and explain the concept of friction choking. (14)

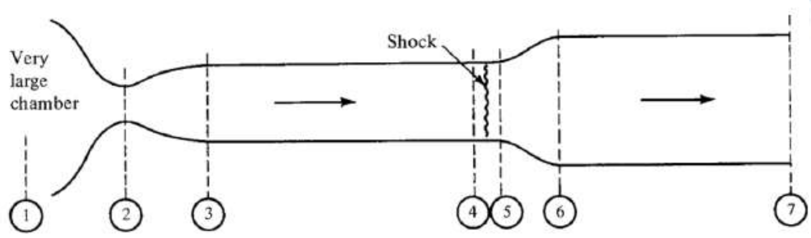
Module 5

19. (a) Explain how thermal chocking happens in flow through varying area duct with the support of property diagrams. (7)

(b). Derive Rankine -Hugoniot equations for a normal shock. (7)

OR

20. There is no friction in the system shown in the figure below except in the constant-area ducts from sections 3 to 4 and from 6 to 7. Sketch the T –s diagram for the entire system. Assume adiabatic flow throughout the system. (14)



B24MEH43	ADVANCED ENGINEERING MATERIALS	L	T	P	S	CREDIT	YEAR OF INTRODUCTION
		3	1	0	3	4	2024

Preamble

This course aims to impart the students a solid comprehension of the engineering materials. By bridging theory and application, students learn to tackle real-world challenges using reasoned assumptions. Emphasizing the key factors that govern the design and selection of materials for use in advanced engineering applications, as well as their processing, properties, and stability. This course aims to empower students with the knowledge of materials used for specific applications and their characteristics.

Prerequisite

Nil

Course Outcomes

After the completion of the course, the student will be able to:

CO 1	Interpret the effect of microstructure variation in mechanical properties of Non-Ferrous materials. (Cognitive Knowledge Level: Understand)
CO 2	Apply the microstructural parameter in the selection of high-temperature materials. (Cognitive Knowledge Level: Apply)
CO 3	Identify suitable materials for solar energy conversion and shape memory effects. (Cognitive Knowledge Level: Apply)
CO 4	Develop composite material for engineering applications. (Cognitive Knowledge Level: Apply)
CO 5	Select biocompatible material for implant application. (Cognitive Knowledge Level: Apply)

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3	3	1							2
CO 2	3	2	3	1								2
CO 3	3	1	1				3					2
CO 4	3	1	1				1					2
CO 5	3	1	3	2	1	3						2

Assessment Pattern

Bloom's Category	Continuous Assessment		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	10	10	20
Understand	60	30	20
Apply	30	60	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

There will be two parts; Part A and Part B. Part A contains 10 questions (2 questions from each module), of 3 marks each and the student should answer all the questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of 2 sub-divisions and carry 14 marks.

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SYLLABUS

MODULE 1 (10 hours)

Non-ferrous metals: Introduction to non-ferrous metals & their alloys: Aluminium Alloys - Classification of Aluminum Alloys, Non-heat treatable Wrought Aluminum Alloys, heat treatable Wrought Aluminum Alloys, Cast Aluminum Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications. Copper Alloys - Copper, Brass and Bronze Phase Diagrams, Compositions, heat treatments, properties and applications. Magnesium Alloys - Classification of Magnesium Alloys, Wrought Magnesium Alloys, Cast Magnesium Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications.

MODULE 2 (9 hours)

High temperature materials: Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. Metals for high temperature service, Ti and Zr alloys, Iron base, nickel base and cobalt base superalloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase - embrittlement, solidification of single crystals, production, properties and applications.

MODULE 3 (8 hours)

Materials for Renewable energy conversion: Photovoltaics - Silicon (Si) solar cells, Crystalline/ Semicrystalline/

Amorphous Si solar cells, thin film solar cells. Photoelectrochemical cells – Semiconductor electrochemistry - Photoelectrolysis, photochemical cells, photocatalysis, Mechanism- electron transfer: Factors affecting electron transfer. Efficiency, limiting factors.

Shape Memory Materials: Shape Memory Alloys (SMA), Shape memory effect, Superelasticity or Pseudoelasticity, Phase Transformation phenomenon in SMAs, Training and stability of SMA, Heating Methods of temperature induced SMA, Types of Shape Memory Alloys, One-way shape memory Alloys, Two-way shape memory, Effect of Thermo-Mechanical Treatments, Effects of Aging, Effect of Grain Size, Effect of Deviation from Equiatomic Stoichiometry, Effect of Additive elements, Effect of Precipitation, Potential Applications, Advantages of SMA materials.

MODULE 4 (9 hours)

Composite materials: Introduction to Composites, function of the matrix and reinforcement in composites.

Classification: polymer matrix composites, metal matrix composites, ceramic matrix composites. Manufacturing Methods: Polymer Matrix Composites-Thermoset Composite manufacturing- Layup processes, Spray-up process, Filament winding; Thermoplastic Composite manufacturing- Film Stacking, Diaphragm Forming, Thermoplastic Tape Laying. Metal Matrix Composites- Solid state methods- hot isostatic pressing (HIP), Foil diffusion bonding. Liquid state methods- Pressure infiltration, Dispersion Processes. Ceramic matrix composites- sintering, CVD.

MODULE 5 (9 hours)

Biomaterials: Introduction and importance of biomaterials; Types of biomaterials: Metallic, ceramic, polymeric and composite biomaterials. Classification according to physiological response of biomaterials: bioinert, bioactive and bioresorbable biomaterials, Governing Factors of Biomaterials, Surface modifications; Surface analysis, In Vitro and in vivo assessment of tissue compatibility.

Text Books

1. William F. Smith, "Structure and Properties of Engineering Alloys", 2nd Edition, McGraw-Hill.
2. Ajit Behera, "Text Book: Advanced Materials", 1st edition, Springer Nature.

Reference Books

1. R. E. Smallman & R. J. Bishop, "Modern Physical Metallurgy and Materials Engineering Science, process, applications", 6th Edition, Butterworth-Heinemann.
2. Matthew J. Donachie & Stephen J. Donachie, "SUPERALLOYS A Technical Guide", 2nd Edition, ASM International.
3. Juan M. Coronado, Fernando Fresno, María D. Hernández-Alonso and Raquel Portela, "Design of Advanced Photocatalytic Materials for Energy and Environmental Applications", Springer.
4. Krishan K. Chawla, "Composite Materials Science and Engineering", 3rd Edition, Springer.
5. J.B. Park and J.D. Bronzino, "Biomaterials: Principles and Applications", CRC Press.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures/ Tutorial hours
	Module 1	**10**
1.1	Introduction to non-ferrous metals & their alloys.	1
1.2	Aluminum Alloys - Classification of Aluminum Alloys, Non-heat treatable Wrought Aluminum Alloys, heat treatable Wrought Aluminum Alloys, Cast Aluminum Alloys with their Phase Diagrams.	1
1.3	Aluminum Alloys - Compositions, heat treatments, properties and applications.	2
1.4	Copper Alloys - Copper, Brass and Bronze Phase Diagrams.	1
1.5	Copper Alloys - Compositions, heat treatments, properties and applications.	2
1.6	Magnesium Alloys - Classification of Magnesium Alloys, Wrought Magnesium Alloys, Cast Magnesium Alloys with their Phase Diagrams.	1

1.7	Magnesium Alloys - Compositions, heat treatments, properties and applications.	2
	Module 2	**9**
2.1	Factors influencing functional life of components at elevated temperatures,	1
2.2	Definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.	2
2.3	Metals for high temperature service, Ti and Zr alloys, Iron base, nickel base and cobalt base superalloys	2
2.4	composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase - embrittlement,	3
2.5	solidification of single crystals, production, properties and applications.	1
	Module 3	**8**
3.1	**Materials for Renewable energy conversion:** Photovoltaics - Silicon (Si) solar cells, Crystalline/ Semicrystalline/ Amorphous Si solar cells, thin film solar cells.	1
3.2	Photoelectrochemical cells – Semiconductor electrochemistry - Photoelectrolysis, photochemical cells.	1
3.3	phootcatalysis, Mechanism- electron transfer: Factors affecting electron transfer. Efficiency, limiting factors.	2
3.4	**Shape Memory Materials**: Shape Memory Alloys (SMA), Shape memory effect, Superelasticity or Pseudoelasticity, Phase Transformation phenomenon in SMAs.	1
3.5	Training and stability of SMA, Heating Methods of temperature induced SMA,	1
3.6	Types of Shape Memory Alloys, One-way shape memory Alloys, Two-way shape memory,	1
3.7	Effect of Thermo-Mechanical Treatments, Effects of Aging, Effect of Grain Size, Effect of Deviation from Equiatomic Stoichiometry, Effect of Additive elements, Effect of Precipitation, Potential Applications, Advantages of SMA materials.	1
	Module 4	**9**
4.1	**Composite materials**: Introduction to Composites, function of the matrix and reinforcement in composites.	1
4.2	Classification: polymer matrix composites, metal matrix composites, ceramic matrix composites.	1
4.3	Manufacturing Methods: Polymer Matrix Composites-Thermoset Composite manufacturing- Layup processes, Sprayup process, Filament winding;	1
4.4	Thermoplastic Composite manufacturing- Film Stacking, Diaphragm Forming, Thermoplastic Tape Laying.	2
4.5	Metal Matrix Composites- Solid state methods- hot isostatic pressing (HIP), Foil diffusion bonding.	2

4.6	Liquid state methods- Pressure infiltration, Dispersion Processes. Ceramic matrix composites- sintering, CVD.	2
	Module 5	**9**
5.1	**Biomaterials:** Introduction and importance of biomaterials; Types of biomaterials: Metallic, ceramic, polymeric and composite biomaterials.	3
5.2	Classification according to physiological response of biomaterials: bioinert, bioactive and bioresorbable biomaterials,	3
5.3	Governing Factors of Biomaterials, Surface modifications; Surface analysis, In Vitro and in vivo assessment of tissue compatibility.	3
	Total	**45 hours**

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. What are the advantages of using non-ferrous metals in industrial applications?
2. How are non-ferrous metals classified based on their properties and applications?
3. What are the main differences between wrought and cast aluminum alloys?
4. How does the addition of zinc affect the properties of copper in brass alloys?
5. How do magnesium alloys compare with aluminum alloys in terms of strength and weight?
6. Evaluate the applications of copper alloys in electrical and marine industries. Why is copper preferred for electrical applications?
7. Explain the significance of heat treatment in magnesium alloys. What challenges are faced in processing magnesium alloys?

Course Outcome 2 (CO2):

1. What are the key factors that influence the functional life of components operating at high temperatures?
2. What is thermal fatigue, and why is it important for high-temperature materials?
3. Explain the effect of applied stress on creep deformation.
4. How does oxidation and corrosion affect high-temperature materials?
5. What is the role of solid solution strengthening in high-temperature alloys?
6. Explain the role of Topologically Close-Packed (TCP) phases in the embrittlement of superalloys.
7. What are the challenges associated with solidification of single-crystal superalloys?

Course Outcome 3 (CO3):

1. What are the limitations of silicon-based solar cells, and how can they be improved?
2. . How does photocatalysis differ from photochemical cells?
3. What is the effect of grain size on the properties of SMAs?
4. What are the advantages and limitations of shape memory alloys?
5. How do superelasticity and pseudoelasticity differ from the shape memory effect?
6. How does phase transformation contribute to the shape memory behavior?
7. What are the major factors affecting electron transfer in PEC systems?

Course Outcome 4 (CO4):

1. What role does the reinforcement play in composite materials?
2. How do composites achieve superior mechanical properties compared to individual materials?
3. What are the advantages of polymer matrix composites (PMCs)?
4. What is filament winding, and where is it commonly used?
5. How does the pressure infiltration method work for liquid-state MMC processing?
6. What are the main manufacturing methods for ceramic matrix composites?
7. How does the hand layup process work in thermoset composite manufacturing?

Course Outcome 5 (CO5):

1. Define biomaterials and mention their importance in medical applications.
2. What are the governing factors of biomaterials?
3. List any two advantages and disadvantages of metallic biomaterials.
4. What is in vivo testing of biomaterials? How is it different from in vitro testing?
5. What are the techniques used for surface analysis of biomaterials?
6. What are bioresorbable biomaterials? How do they work in the body?
7. What are composite biomaterials, and why are they advantageous?

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MODEL QUESTION PAPER

QP CODE: Pages: 2

Reg. No.: ....

Name: ....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FOURT SEMESTER B TECH DEGREE EXAMINATION, APRIL 2026

Course Code: **B24MEH43**

Course Name: **ADVANCED ENGINEERING MATERIALS**

Max. Marks: 100 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks.

1. How are aluminum alloys classified?
2. What are the key properties of pure copper?
3. Explain the role of microstructural stability in determining the lifespan of high-temperature components.
4. What are the metallurgical factors that influence the different stages of creep?
5. What factors affect the efficiency of photovoltaic (PV) cells?
6. What is the shape memory effect, and how does it work in SMAs?
7. What are the main functions of the matrix in a composite material?
8. How does hot isostatic pressing (HIP) work in MMC manufacturing?
9. Differentiate between bioinert, bioactive, and bioresorbable biomaterials.
10. Explain the difference between in vitro and in vivo assessment of tissue compatibility.

PART B

Answer any one question from each module. Each question carries 14 marks.

Module 1

11. Discuss the role of heat treatment in aluminum alloys. Explain the different heat treatment processes used and their effects on mechanical properties. (14 marks)

OR

12. Magnesium alloys are highly susceptible to corrosion. Discuss the factors affecting their corrosion resistance and the methods used to improve it. (14marks)

Module 2

13. Define a creep curve and explain its significance. (14marks)

OR

14. Describe the production methods used for single-crystal superalloys. (14marks)

Module 3

15. Describe the mechanism of photoelectrochemical (PEC) cells and their role in renewable energy conversion. What are the major challenges in improving their efficiency? (14marks)

OR

16. Evaluate the role of additive elements and precipitation in modifying the mechanical and thermal properties of SMAs. (14marks)

Module 4

17. How does sintering help in ceramic matrix composite fabrication? (14marks)

OR

18. What is chemical vapor deposition (CVD), and how is it used in CMC manufacturing (14marks)

Module 5

19. Discuss the importance of surface modifications in biomaterials. Explain different surface modification techniques and their applications. (14 marks)

OR

20. What are the common tests used to assess biocompatibility? (14 marks)