MAR ATHANASIUS COLLEGE OF ENGINEERING

(Government Aided &Autonomous)

Kothamangalam 686 666

Affiliated to APJ Abdul Kalam Technological University

Thiruvananthapuram

Master of Technology (M. Tech.)

Curriculum - 2024

COLLEGE VISION AND MISSION

VISION

Excellence in education through resource integration.

MISSION

The institution is committed to transform itself into a centre of excellence in Technical Education upholding the motto "Knowledge is Power."

This is to be achieved by imparting quality education to mould technically competent professionals with moral integrity, ethical values and social commitment, and by promoting innovative activities in the thrust areas emerging from time to time.

MAR ATHANASIUS COLLEGE OF ENGINEERING

(GOVT. AIDED & AUTONOMOUS)

M.TECH CURRICULUM AND SCHEME-2024

Department of Mechanical Engineering

Production & Industrial Engineering

PROGRAM OUTCOMES – PO

Outcomes are the attributes that are to be demonstrated by a graduate after completing the programme

PO1: An ability to independently carry out research/investigation and development work in engineering and allied streams

PO2: An ability to communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to apply stream knowledge to design or develop solutions for real world problems by following the standards

PO5: An ability to identify, select and apply appropriate techniques, resources and state-of-the-art tools to model, analyze and solve practical engineering problems.

PO6: An ability to engage in life-long learning for the design and development of the stream related problems taking into consideration sustainability, societal, ethical and environmental aspects. Also to develop cognitive skills for project management and finance which focus on Industry and Entrepreneurship.

The departments conducting the M.Tech programme shall define their own PSOs, if required, and assessment shall also be done for the same.

SEMESTER I

Slot	Course Code	Course	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M24ME2T101	Numerical Methods for Engineers	40	60	4-0-0-4	4	4
B	M24ME1T102	Advanced Welding and Casting	40	60	4-0-0-4	4	4
C	M24ME1T103	Applied Materials Engineering	40	60	4-0-0-4	4	4
D	M24ME1E104A	Programme Elective 1	40	60	3-0-0-3	3	3
E	M24ME1E105A	Programme Elective 2	40	60	3-0-0-3	3	3
J	M24ME2R106	Research Methodology & IPR	40	60	2-0-0-2	2	2
G	M24ME1L107	Production Engineering Lab	100	0	0-0-3-2	3	2
	Total		340	360		23	22

Teaching Assistance: 7 hours Self-study- 22 Hrs

Programme Elective 1

Slot	Course Code	Course	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
D	M24ME1E104A	Quality Engineering and Management	40	60	3-0-0-3	3	3
D	M24ME1E104B	Computer Aided Manufacturing	40	60	3-0-0-3	3	3
D	M24ME1E104C	Design of Machine Tool Systems	40	60	3-0-0-3	3	3

Programme Elective 2

Slot	Course Code	Course	Marks		L-T-P- S	Hours	Credit
			CIE	ESE			
E	M24ME1E105A	Robotics and Automation	40	60	3-0-0-3	3	3
E	M24ME1E105B	Optimization Techniques	40	60	3-0-0-3	3	3
E	M24ME1E105C	Flexible Manufacturing Systems	40	60	3-0-0-3	3	3

SEMESTER II

Slot	Course Code	Course	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M24ME1T201	Advanced Metal Forming	40	60	4-0-0-4	4	4
B	M24ME1T202	Industrial Tribology	40	60	4-0-0-4	4	4
C	M24ME1E203A	Programme Elective 3	40	60	3-0-0-3	3	3
D	M24ME1E204A	Programme Elective 4	40	60	3-0-0-3	3	3
E	M24ME1S205	Industrial integrated course - Design and simulation of production tooling and Manufacturing system (Stamptek)	40	60	3-0-0-3	3	3
G	M24ME1P206	Mini project	100	--	0-0-3-2	3	2
H	M24ME1T207	Computational Engineering Lab	100	--	0-0-3-2	3	2
	Total		400	300		23	21

Teaching Assistance: 7 hours Self-study- 21 Hr

Programme Elective 3

Slot	Course Code	Course	Marks		L-T-P- S	Hours	Credit
			CIE	ESE			
C	M24ME1E203A	Computational Fluid Dynamics	40	60	3-0-0-3	3	3
C	M24ME1E203B	Metrology and Computer Aided Inspection	40	60	3-0-0-3	3	3
C	M24ME1E203C	Micro and Nano Machining	40	60	3-0-0-3	3	3

Programme Elective 4

Slot	Course Code	Course	Marks		L-T-P- S	Hours	Credit
			CIA	ESE			
D	M24ME1E204A	Finite Element Methods	40	60	3-0-0-3	3	3
D	M24ME1E204B	Statistical Methods for Engineering	40	60	3-0-0-3	3	3
D	M24ME1E204C	Manufacturing and Mechanics of Composites	40	60	3-0-0-3	3	3

SEMESTER III

TRACK 1							
Slot	Course Code	Course	Marks		L-T-P-S	Hours	Credit
			CIE	ESE			
A	M24ME1M301	* MOOC	To be completed successfully		--		2
B	M24ME1M302	Programme Elective 5	40	60	3-0-0-3	3	3
K	M24ME1I303	**Internship	50	50	--		3
P	M24ME1P304	###Dissertation Phase 1	100	--	0-0-16-16	16	11
	Total		190	110		23	19
TRACK II							
A	M24ME1M305	* MOOC 1	To be completed successfully		--	--	2
B	M24ME1M306	* MOOC 2	To be completed successfully		--	--	2
K	M24ME1MI307	## Internship	50	50	--	--	4
P	M24ME1P307	###Dissertation Phase 1	100	--	--	--	11
			150	50			19

Teaching Assistance : 7 hours

Programme Elective 5

Slot	Course Code	Course	Marks		L-T-P- S	Hours	Credit
			CIE	ESE			
A	M24ME1E301A	Tools for Manufacturing and Automation	40	60	3-0-0-3	3	3
A	M24ME1E302B	Modern Manufacturing Process	40	60	3-0-0-3	3	3
A	M24ME1E303C	Soft Computing Methods	40	60	3-0-0-3	3	3

Teaching Assistance: 6 hours

*MOOC Course of minimum 8 weeks duration to be successfully completed before the end of fourth semester (starting from semester 1).

**Internship- mandatory internship of 6 to 8 weeks

Internship - mandatory internship of more than 16 weeks

###Dissertation Phase 1 – Should be done in Industry

TRACK 1 / TRACK 2

In second year, the students can choose either of the two tracks: TRACK 1 or TRACK 2. Track 1 is a conventional M.Tech programme in which the dissertation Phase 1 is conducted at college. Track 2 is M.Tech programme designed for students who have undergone long term internship (not less than 16 weeks) in industry. An aspirant in track 2 needs to do the dissertation in the industry. The candidates should also be good with performing in-depth research and colluding the conclusions of research led by them. Such students are expected to have the following skills: Technical Skills, Research Skills, Communication Skills, Critical Thinking Skills, and Problem-Solving Skills.

The eligibility for Track 2:

- Shall have qualified in the GATE or have a SGPA above 8.0 during the first semester, and
- Qualify an interview during the end of second semester by an expert committee constituted by the College.

SEMESTER IV

TRACK 1							
Slot	**Course Code**	**Course**	**Marks**		**L-T-P-S**	**Hours**	**Credit**
			CIA	**ESE**			
P	**M24ME1P401**	**[##]Dissertation Phase II**	**100**	**100**	**0-0-27-24**	**27**	**18**
	Total		**100**	**100**		**27**	**18**
P	**M24ME1P402**	**[##]Dissertation Phase II**	**100**	**100**			**18**
	Total		**100**	**100**			**18**
Total credits in all four semesters							**80**

[##]Dissertation Phase II- Should be done in Industry

COURSE NUMBERING SCHEME

The course number consists of digits/alphabets. The pattern to be followed is

The course number consists of digits/alphabets. The pattern to be followed is

For General Courses -MYYBBXCSNN For Elective Courses - MYYBBXCSNNA

- M: MASTERS
- YY: Last two digits of year of regulation
- BB: DEPARTMENT

Sl.No	Department	Course Prefix
01	Civil Engg	CE
02	Computer Science	CS
03	Electrical & Electronics	EE
04	Electronics & Communication	EC
05	Mechanical Engg	ME
06	Any	GE
07	External (Industry/NPTEL etc)	EX

- X :Specialization number
- S : Semester of Study

2- Semesters 1

3- Semester 2

4- Semester 3

5- Semester 4

C: Course Type

T- Core Course

E- Elective Course

R- Research Methodology & IPR L- Laboratory Course

S- Industry Integrated Course I- Internship- MOOC

P- Project/Dissertation

- NN: Course sequence number
- A: Elective sequence number - A/B/C/D/E It is illustrated below: Examples:

M24CE1T202 is a second core course of first specialization offered by the Civil Department in semester 2

M24EC1R106 is Research Methodology & IPR offered in semester 1 M24EC1E104A is the first subject of Elective 1 of first specialization offered by the EC Department in semester 1

ASSESSMENT PATTERN

(i) CORE COURSES

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Assessment	**: 40 marks**
Micro project/Course based project	:10marks
Course based task/Seminar/Quiz	: 10 marks
Test paper 1 (Module 1 and Module 2)	:10 marks
Test paper 2 (Module 3 and Module 4)	:10 marks

The project shall be done individually (Preferable).

End Semester Examination	: 60 marks

The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing

of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.ELECTIVE COURSES

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Assessment: 40 marks

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course.

End Semester Examination: 60 marks

The end semester examination will be conducted by the College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 4 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

(ii) RESEARCH METHODOLOGY & IPR

Continuous Internal Assessment: 40 marks

Preparing a review article based on peer reviewed Original publications in the relevant discipline (minimum 10 publications shall be referred) : 10 marks

: 10 marks

Course based task/Seminar/Quiz

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination : 60 marks

The end semester examination should be conducted by the college. The time duration will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

(iii) INTERNSHIP

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated or non-compensated by the organization providing the internship. The internship has to be meaningful and mutually beneficial to the intern and the organization. It is important that the objectives and the activities of the internship program are clearly defined and understood. The internship offers the students an opportunity to gain hands-on industrial or organizational exposure; to integrate the knowledge and skills acquired through the coursework; interact with professionals and other interns; and to improve their presentation, writing, and communication skills. Internship often acts as a gateway for final placement for many students.

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall

be related to their specialization after the second semester for a minimum duration of six to eight weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

Objectives

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

Benefits ofInternship

Benefits to Students

- An opportunity to get hired by the Industry/ organization.
- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom teaching.
- Helps them decide if the industry and the profession is the best career option to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.
- Creating networks and social circles and developing relationships with industry people.

- Provides opportunity to evaluate the organization before committing to a full time position.

Benefits to the Institute

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry students.
- Improvement in teaching learning process.

Benefits to the Industry

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.
- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long term employer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

Types of Internships

(iv) Industry Internship with/without Stipend

- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centers /Start-ups **Guidelines**
- All the students need to go for an internship for a minimum duration of 6 to 8 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.

- ☐ All students should compulsorily follow the rules and regulations as laid by industry.
- ☐ Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- ☐ Students should follow all ethical practices and SOP of industry.
- ☐ Students have to take necessary health and safety precautions as laid by the industry.
- ☐ Students should contact his /her Guide/Supervisor from college on a weekly basis to communicate the progress.
- ☐ Each student has to maintain a diary/log book
- ☐ After completion of internship, students are required to submit
- Report of work done
- Internship certificate copy
- Feedback from employer / internship mentor
- Stipend proof (in case of paid internship).

Total Marks 100: The marks awarded for the Internship will be on the basis of (i) Evaluation done by the Industry (ii) Students diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

Continuous Internal Assessment: 50 marks

Student's diary	- 25 Marks
Evaluation done by the Industry	- 25 Marks

Student's Diary/ Daily Log: The main purpose of writing a daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

(v) Regularity in maintenance of the diary

(vi) Adequacy & quality of information recorded

(vii) Drawings, design, sketches and data recorded ➢ Thought process and recording techniques used

(viii) Organization of the information.

(ix)

The format of student's diary

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Brief description about the nature of internship:

Day	Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc.
1	
2	
3	

Signature of Industry Supervisor *Signature of SectionHead/HR Manager*

Office Seal

Attendance Sheet

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	...
Month & Year																					
Month & Year																					

Signature of Industry Supervisor *Signature of Section Head/HRManager*

Office Seal

Note:

- ☐ Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- ☐ The Attendance Sheet should remain affixed in the daily training diary. Do not remove or tear it off.
- ☐ Students shall sign in the attendance column. Do not mark 'P'.
- ☐ Holidays should be marked in red ink in the attendance column. Absent should be marked as 'A' in red ink.

Evaluation done by the Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name :_____Date:

Please evaluate intern by indicating the frequency with which you observed the

Student Name: _____ Date: _____Supervisor Name: _____

Designation:_____Company/Organization: _____ Internship Address: _____ Date of Internship:From _____ to_____

Parameters Marks	Needs improvement (0 –0.25 mark)	Satisfactory (0.25 –0.50 mark)	Good (0.75 mark)	Excellent (1 mark)
Behavior				
Performs in a dependable Manner				
Cooperates with coworkers and supervisor				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				
Communicates well				

Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student

Intern (Tick one) : Needs improvement (0 - 0.50 mark) / Satisfactory (0.50 – 1.0 mark) / Good (1.5 mark) / Excellent (2.0 mark) Additional comments, if any (2 marks) :

Signature of Industry Supervisor *Signature of Section Head/HRManager*

Office Seal

End Semester Evaluation (External Evaluation): 50 Marks

Internship Report - 25 Marks

Viva Voce - 25 Marks

Internship Report: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student may contact the Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Viva Voce (25 Marks) will be done by a committee comprising Faculty Supervisor, PG

Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

(x) LABORATORY COURSES

Lab work and Viva-voce : 60 marks

Final assessment Test and Viva voce : 40 marks

The laboratory courses will be having only Continuous Internal Assessment and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

(xi) INDUSTRY INTEGRATED COURSE

Engineering students frequently aspire to work in areas and domains that are key topics in the industry. There are concerns by recruiters that skill sets of engineering students did not match with the Industry requirements, especially in the field of latest topics. In response to their desires, the College has incorporated Industry integrated courses in the curriculum.

The assessment pattern for Industry based electives is as follows:

Continuous Internal Assessment: 40 marks

Seminar : 10 marks

Course based task/Seminar/Data collection and interpretation/Case study : 10marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination: 60 marks

The examination will be conducted by the College with the question paper provided by the Industry. The examination will be for 3 Hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks. The valuation of the answer scripts shall be done by the expert in the Industry handling the course.

(xii) MOOC COURSES

The MOOC course shall be considered only if it is conducted by the agencies namely

AICTE/NPTEL/SWAYAM or NITTTR. The MOOC course should have a minimum duration of 8 weeks and the content of the syllabus shall be enough for at least 40 hours of teaching. The course should have a proctored/offline end semester examination. The students can do the MOOC according to their convenience, but shall complete it before the end of fourth semester. The list of MOOC courses will be provided by the concerned BoS if at least 70% of the course content matches with the area/stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/elective course in the concerned discipline or with an open elective.

MOOC Course to be successfully completed before the end of fourth semester (starting from semester 1). A credit of 2 will be awarded to all students whoever successfully completes the MOOC course as per the evaluation pattern of the respective agency conducting the MOOC.

(xiii) MINI PROJECT

Total marks: 100, only CIA

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem- solving skills. The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with the PG Programme Coordinator. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review.

A report is required at the end of the semester.

Interim evaluation: 40 (20 marks for each review), final evaluation by a Committee (will be evaluating the level of completion and demonstration of functionality/specifications, clarity of presentation, oral examination, work knowledge and involvement): 35, Report (the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level is not more than 25%): 15, Supervisor/Guide: 10

DISSERTATION

Dissertation: All Students should carry out the dissertation in the college or can work either in any CSIR/Industrial R&D organization/any other reputed Institute which have facilities for dissertation work in the area proposed.

Dissertation outside the Institute: For doing dissertation outside the Institution, the following

conditions are to be met:

- They have completed successfully the course work prescribed in the approved curriculum up to the second semester.
- They should choose Track 2 in semester 3 and 4
- The student has to get prior approval from the DLAC and CLAC.
- Facilities required for doing the dissertation shall be available in the Organization/Industry (A certificate stating the facilities available in the proposed organization and the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/Industry shall be submitted by the student along with the application).
- They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from the Institution/Industry/ R&D organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area.he student has to furnish his /her monthly progress as well as attendance report signed by the external guide and submit the same to the concerned Internal guide.
- The external guide is to be preferably present during all the stages of evaluation of the dissertation.

Note1- Students availing this facility should continue as regular students of the College itself.

Note 2-The course work in the 3rd semester is to be completed as per the curriculum requirements (i) MOOC can be completed as per the norms mentioned earlier

Internship leading to Dissertation: The M. Tech students who after completion of 6 to 8 weeks internship at some reputed organization are allowed to continue their work as dissertation for the third and fourth semester after getting approval from the DLAC. Such students shall make a brief presentation regarding the work they propose to carry out before the DLAC for a detailed scrutiny and to resolve its suitability for accepting it as an M.Tech

dissertation. These students will be continuing as regular students of the Institute in the third semester for carrying out all academic requirements as per the curriculum/regulation. However, they will be permitted to complete their dissertation in the Industry/Organization (where they have successfully completed their internship) during the fourth semester.

Dissertation as part of Employment: Students may be permitted to discontinue the programme and take up a job provided they have completed all the courses till second semester (FE status students are not permitted) prescribed in the approved curriculum. The dissertation work can be done during a later period either in the organization where they work if it has an R & D facility, or in the Institute. Such students should submit an application with details (copy of employment offer, plan of completion of their project etc.) to the Dean (PG) through HoD. The application shall be vetted by CLAC before granting the approval. When the students are planning to do the dissertation work in the organization with R & D facility where they are employed, they shall submit a separate application having following details:

- Name of R&D Organization/Industry
- Name and designation of an external supervisor from the proposed Organization/Industry (Scientists or Engineers with a minimum post graduate degree in the related area) and his/her profile with consent
- Name and designation of a faculty member of the Institute as internal supervisor with his/her consent
- Letter from the competent authority from the Organization/Industry granting permission to do the dissertation
- Details of the proposed work
- Work plan of completion of project

DLAC will scrutinize the proposal and forward it to CLAC for approval.

When students are doing dissertation work along with the job in the organization (with R & D facility) where they are employed, the dissertation work shall be completed in four semesters normally (two semesters of dissertation work along with the job may be considered as equivalent to one semester of dissertation work at the Institute). Extensions may be granted based on requests from the student and recommendation of the supervisors such that he/she will complete the M. Tech programme within four years from the date of admission as per the

regulation. Method of assessment and grading of the dissertation will be the same as in the case of regular students. The course work in the 3rd semester for such students is to be completed as per the curriculum requirements (i) MOOC can be completed as per the norms mentioned earlier. However, for self learning students, all assessments shall be carried out in their parent Institution as in the case of regular students.

Mark Distribution:

Phase 1: Total marks: 100, only CIA

Phase 2: Total marks: 200, CIA = 100 and ESE = 100 marks

- Maximum grade (S grade) for the dissertation phase II will be awarded preferably if the student publishes the dissertation work in a peer reviewed journal.
- Final Evaluation (ESE) should be done by a three-member committee comprising of the Department Project coordinator, Guide and an External expert. The external expert shall be an academician or from industry.

(xiv) TEACHING ASSISTANCESHIP (TA)

All M.Tech students irrespective of their category of admission, shall undertake TA duties for a minimum duration as per the curriculum. Being a TA, the student will get an excellent opportunity to improve their expertise in the technical content of the course, enhance communication skills, obtain hands-on experience in handling the experiments in the laboratory and improve peer interactions.

The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate the students for a laboratory course, serve as a mentor for students, and act as the course webmaster. TAs may be required to attend the instructor's lecture regularly. A TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.

For the tutorial session:

(i) Meet the teacher and understand your responsibilities well in advance, attend the lectures of the course for which you are a tutor, work out the solutions for all the tutorial problems yourself, approach the teacher if you find any discrepancy or if you need help in solving the tutorial problems, use reference text books, be innovative and express everything in English only.

(ii) Try to lead the students to the correct solutions by providing appropriate hints rather than

solving the entire problem yourself, encourage questions from the students, lead the group to a discussion based on their questions, plan to ask them some questions, be friendly and open with the students, simultaneously being firm with them.

(iii) Keep track of the progress of each student in your group, give a periodic feedback to the student about his/her progress, issue warnings if the student is consistently under-performing, report to the faculty if you find that a particular student is consistently underperforming, pay special attention to slow-learners and be open to the feedback and comments from the students and faculty.

(iv) After the tutorial session you may be required to grade the tutorials/assignments/tests. Make sure that you work out the solutions to the questions yourself, and compare it with the answer key, think and work out possible alternate solutions to the same question, understand the marking scheme from the teacher. Consult the teacher and make sure that you are not partial to some student/students while grading. Follow basic ethics.

Handling a laboratory Session:

Meet the faculty – in- charge a few days in advance of the actual lab class and get the details of the experiment, get clarifications from him/her regarding all aspects of the experiment and the expectations, prepare by reading about the theoretical background of the experiment, know the physical concepts involved in the experiment, go to the laboratory and check out the condition of the equipment/instrumentation, perform the laboratory experiment at least once one or two days before the actual laboratory class, familiarize with safety/ security aspects of the experiment / equipment/laboratory, prepare an instruction sheet for the experiment in consultation with the faculty, and keep sufficient copies ready for distribution to students for their reference.

(i) Verify condition of the equipment/set up about 30 minutes before the students arrive in the class and be ready with the hand outs, make brief introductory remarks about the experiment, its importance, its relevance to the theory they have studied in the class, ask the students suitable questions to know there level of preparation for the experiment, discuss how to interpret results, ask them comment on the results.

(ii) Correct/evaluate/grade the submitted reports after receiving suitable instructions from the faculty in charge, continue to interact with students if they have any clarifications regarding any aspect of the laboratory session, including of course grading, Carefully observe instrument and human safety in laboratory class, Preparing simple questions for

short oral quizzing during explanation of experiments enables active participation of students, facilitate attention, provides feedback and formative assessment.

POINTS TO REMEMBER

1. Arrange an awareness programme to all M.Tech students on day 1 regarding the curriculum and the regulation.
2. The departments should prepare the list of MOOC courses suitable to their programmes and encourage the students to complete at the earliest.
3. Make a tie up with industries by the middle of semester for Industry Integrated Course. While choosing the course, it should be ensured that the programme is relevant and updated in that discipline. The Industry expert handling the course shall be a postgraduate degree holder. The evaluation procedure shall also be clearly explained to them.
4. Each department offering M.Tech programmes should be careful in selecting the mini project in semester 2.
5. The departments should invite the Industries/research organizations during first semester and inform them about the mandatory 6-8 weeks internship that the students should undergo after their second semester. The possibility of doing their dissertation at the Industry shall also be explored. They should also be made aware about the evaluation procedure of the Internships. They May also be informed that it is possible to continue the internship provided if it leads to their dissertation. Proposals may be collected from them for allotting to students according to their fields of interest.
6. Make sure that all internal assessments and the end semester examinations to be conducted by the college are carried out as per the assessment procedure listed in the curriculum. Any dilution from the prescribed procedure shall be viewed seriously.
7. Teaching assistance shall be assigned to all students as per the curriculum. However, a TA shall not be employed as a substitute instructor, where the effect is to relieve the instructor of his or her teaching responsibilities.
8. The possible TA responsibilities include the following: facilitate a discussion section or tutorial for a theory/ course, facilitate to assist the students for a laboratory course, serve as a mentor for students, and act as the course web-master.

****

Semester 1

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME2T101	Numerical Methods for Engineers	Core	4	0	0	4	4

Preamble: Mechanical engineers rely heavily on numerical simulations as their primary tool for addressing challenges in thermo-fluid systems. The utilization of advanced computational methods is integral to this process. This course aims to familiarize participants with the sophisticated numerical techniques essential for solving problems in mechanical engineering.

Prerequisite: A foundation course in linear algebra, differential equations and computer programming

Course Outcomes: After The completion of the course the student will be able to

CO No	CO Statements	Cognitive Knowledge Level
CO 1	Acquire skills necessary for formulating and solving engineering problems through computational methods, illustrated through case studies and computer programming	Apply
CO 2	Proficiently utilize curve fitting techniques for practical situations.	Apply
CO 3	Apply computational techniques of numerical differentiation and integration for real life situations and implement through computer programming	Apply
CO 4	Apply numerical methods for solving ordinary differential equations and Eigen values by practical case studies and implementation through computer programs	Apply
CO 5	Analyze different interpolation techniques, alongside the solution of partial differential equations using difference equations for real life situations and implement through computer programming	Analyze

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2		2	2	2	1
CO 2	1		2	2	2	1
CO 3	1		2	2	2	1
CO 4	1		2	2	2	1

CO 5	1		2	2	2	1

Assessment Pattern

	Numerical Methods for Engineers		
Bloom's Category	**Continuous Assessment Tests**		**End SemesterExamination (Marks %)**
	Test 1 (Marks %)	**Test 2 (Marks %)**	
Remember	XX	XX	XX
Understand	20	20	20
Apply	60	60	60
Analyze	20	20	20
Evaluate	XX	XX	XX
Create	XX	XX	XX

Mark distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application,analysis, synthesis, evaluation and

understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (9 Hours)

Introduction to Computational methods, system of equations-Revision - Formulation of engineering problems and solution using computational methods; significant figures, accuracy, precision, round off error, truncation error, Taylor series expansion of a polynomial. Roots of equation - Bisection, Newton-Raphson, and Bairstow methods. Linear algebraic equations - Gauss Elimination method, LU decomposition. Non-linear equation

Gauss-Jordan method, Newton- Raphson for simultaneous equations. Case studies with computer programs (Python/Scilab/ C++/Fortran/other).

MODULE 2 (9 Hours)

Curve fitting- Linear regression- linearization of nonlinear relation, linear least squares, multiple linear regression. Nonlinear regression- polynomial regression, Gauss- Newton method. Case studies with computer programs (Python/Scilab/ C++/Fortran/other).

MODULE 3 (9 Hours)

Numerical differentiation and integration- Derivatives- Newton's forward, backward, divided difference and Sterling formula. Integration -Trapezoidal rule, Simpsons one third, Simpsons three eighth, Gauss quadrature two & three points. Case studies with computer programs (Python/Scilab/ C++/Fortran/other).

MODULE 4 (9 Hours)

Numerical solutions to ordinary differential equations- Taylor's method, Euler's method, Runge-Kutta method fourth order, simultaneous first order, Milne's predictor corrector. Initial value problem - shooting method, Eigenvalues - polynomial method, power method. Case studies with computer programs (Python/Scilab/ C++/Fortran/other).

MODULE 5 (9 Hours)

Solution of partial differential equation & Interpolation- Interpolation - Newton's forward and backward, divided difference linear & quadratic, Lagrange interpolation, cubic splines, Hermite's interpolation. Solution of partial differential equation - Difference equations, Elliptic equation- Laplace equation, Poisson equation, Liebmann's iterative methods, Parabolic equation- Bender-Schmidt method, simple implicit, Crank- Nicolson scheme, Solution of hyperbolic equation. Case studies with computer programs (Python/Scilab/ C++/Fortran/other).

Reference Books

1. Steven C. Chapra, Raymond P Canale, "Numerical Methods for Engineering", 8e, Mc-Graw Hill Education (2020)

2. Gilbert Strang, "Computational Science and Engineering", Wellesley- Cambridge Press (2007) 3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001)
4. S. P. Venkateshan, Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books (2014) 5. VN Vedamurthy & SN Iyengar, "Numerical Methods", S Chand & Co Ltd (2014)
6. P. Kandasamy, K. Thilagavathy and K. Gunavathy., "Numerical Methods", S Chand & Co Ltd (2016)
7. B.S. Grewal, "Numerical Methods in Engineering Science with Programs in C, C++ and MATLAB", (10th edition) Khanna Publisher (2020)
8. AK Jaiswal and Anju Khandelwal, "Computer Based Numerical and Statistical Techniques", New Age International (2009)

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module -1 (9 Hours)	
1.1	**Introduction to Computational methods, system of equations** - Revision - Formulation of engineering problems and solution using computational methods; significant figures, accuracy, precision, round off error, truncation error, Taylor series expansion of a polynomial	2
1.2	Roots of equation - Bisection, Newton Raphson, and Bairstow methods	2
1.3	Linear algebraic equations - Gauss Elimination method, LU decomposition. Non- linear equation- Gauss-Jordan method, Newton- Raphson for simultaneous equations	3
1.4	Case studies with computer programs (Python/Scilab/ C++/ Fortran/ other) (Not for End Semester Examination)	2
	Module -2 (9 Hours)	
2.1	**Curve Fitting -** Linear regression- linearization of nonlinear relation, linear least squares, multiple linear regression	3
2.2	Non-linear regression- polynomial regression, Gauss- Newton method	4

2.3	Case studies with computer programs (Python/Scilab/C++/ Fortran/ other) (Not for End Semester Examination)	2
Module -3 (9 Hours)		
3.1	**Numerical differentiation and integration -** Derivatives - Newton's forward, backward, divided difference and Sterling formula	3
3.2	Integration -Trapezoidal rule, Simpsons one third, Simpsons three eighth, Gauss quadrature-two & three points.	4
3.3	Case studies with computer programs (Python/Scilab/ C++/ Fortran/ other) (Not for End Semester Examination)	2
Module – 4 (9 Hours)		
4.1	**Numerical solutions to ordinary differential equations - Taylor's** method, Eulers method, Runge- Kutta method fourth order, simultaneous first order, Milne's predictor corrector	3
4.2	Initial value problem - shooting method, Eigen values - polynomial method, power method	4
4.3	Case studies with computer programs (Python/Scilab/C++/Fortran/other) (Not for End Semester Examination)	2
Module -5 (9 Hours)		
5.1	**Solution of partial differential equation & Interpolation - Interpolation** - Newtons forward and backward, divided difference linear & quadratic, Lagrange interpolation, cubic splines, Hermites interpolation	3
5.2	Solution of partial differential equation - Difference equations, Elliptic equation- Laplace equation, Poisson equation, Liebmann's iterative methods, Parabolic equation- Bender-Schmidt method, simple implicit, Crank-Nicolson scheme, Solution of hyperbolic equation	4
5.3	Case studies with computer programs (Python/Scilab/C++/ Fortran/other) (Not for End Semester Examination)	2

Model Question Paper

QP CODE: A Pages: 2

Reg No. : _____

Name : _____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME2T101**
Course Name: **Numerical Methods for Engineers**

Max. Marks:60 Duration: 3 hours **PART A**

Answer all questions. Each question carries 4 marks.

1. Explain significant figures and truncation error. An approximate value of π is given by 3.1428571 and its true value is 3.1415926. Find the absolute and relative errors.

2. By the method of Least squares, find the straight line that best fit the following data

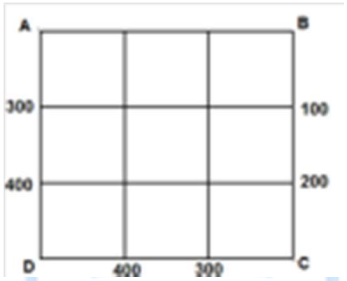
x	1	2	3	4	5
y = f(x)	14	27	40	55	64

3. A function *y = f(x)* is given by the following table. Find *f(0.2)* by a suitable formula.

x	0	1	2	3	4	5	6
y = f(x)	176	185	194	203	212	220	229

4. Solve *dy/dx = x + y, y(0) = 1* with *h =0.2* at *x = 1* by Euler's method

5. Solve the elliptic equation *Uxx + Uyy = 0* for the following square mesh with boundary values as shown below using Liebmann method



PART B

Answer any five questions. Each question carries 8 marks.

6. Find the real root of the equation $x^3 - x - 11 = 0$ using Newton Raphson method.

7. Fit a straight line to the following data and estimate the value of y corresponding to $x = 6$.

x	0	5	10	15	20	25
y	12	15	17	22	24	30

8. Evaluate the following integral:

$$\int_0^{\pi/2} (6 + 3\cos x)\, dx$$

(a) single application of Simpson's 1/3 rule
(b) multiple-application Simpson's 1/3 rule, with n = 4.

9. Evaluate

$$\int_0^1 \frac{dx}{1 + x^2}$$

by two-point and three-point Gassian quadrature formula.

10. Solve the following initial value problem over the interval from t = 0 to 2 where y (0) = 1. Display all your results on the same graph.

$$\frac{dy}{dx} = yt^2 - 1.1y$$

(a) Euler's method with h = 0.5 and 0.25.

(b) Fourth-order RK method with h = 0.5

11. Determine the largest eigen value and the corresponding eigen vector of the matrix using power method.

$$\begin{bmatrix} 1 & 3 & -1 \\ 3 & 2 & 4 \\ -1 & 4 & 10 \end{bmatrix}$$

12. Solve by Schimidth's method $Ut = 5Uxx$ with conditions $U(0,t)\ 0$, $U(5,t) = 60$ and $U(x,0) = 20x$ for $0 \square x \leq \square$, $U\square x,0\square = 60$ for $\square\ \square\ x \leq 5$ for 5 time steps having $h = 1$.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1T102	ADVANCED WELDING AND CASTING	Core	4	0	0	4	4

Preamble:
This course focuses on the key topics of casting and welding. It covers topics such as special casting techniques, casting of MMCs and functionally graded MMCs. Also, mechanism of solidification in metals and alloys is included in this course. This syllabus also features design the gating systems for castings. Details and process characteristics of advanced welding methods such as LBW, FSW, EBW, USW and PAW are included. Also, welding of dissimilar metals, testing of welds, weld distortion and solidification of weld metal are incorporated in this course

Prerequisite:

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

CO NO.	Course Statements	Cognitive Knowledge level
CO 1	To use the concepts of special casting techniques, casting of MMCs and functionally graded MMCs.	Apply
CO 2	To apply the concept of solidification in casting	Apply
CO 3	To design the gating systems for castings	Apply
CO 4	To explain different advanced welding methods such as LBW, FSW, EBW, USW and PAW.	Apply
CO 5	To discuss the welding of dissimilar metals, testing of welds, weld distortion and solidification of weld metal.	Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		3	3		
CO 2	3		3	3		
CO 3	3		3	3	2	
CO 4	3		2	3	1	
CO 5	3		3	3	1	

Assessment Pattern

	ADVANCED WELDING AND CASTING		
Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	25	25	25

Understand	15	15	15
Apply	30	25	30
Analyse	10	10	10
Evaluate	10	15	10
Create	10	10	10

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (9 hours)

Review of casting processes and related equipment: Investment casting- Shell moulding- Squeeze casting- plaster-mould and ceramic-mould casting- high-pressure die casting – lost foam process – Centrifugal casting - casting of metal matrix composites and functionally graded metal matrix composites

MODULE 2 (6 hours)

Directional and monocrystal solidification - Semisolid metal casting- Rheocasting- .Mechanism of solidification in metals and alloys- Nucleation and grain growth- Dendritic growth-Casting economics

MODULE 3 (8 hours)

Design of gating systems- Ferrous and non-ferrous materials used in casting- Defects in castings- Inspection of castings. CAE in casting: Introduction to simulation tools in casting.

MODULE 4 **(9 hours)**

Review of welding processes- Process selection- Types of weld joint- Weldability- Laser Beam Welding: Types of lasers- Equipment- Power calculation- Applications- Dual laser beam welding

Details and process characteristics of advanced welding methods: Friction stir welding- Electron beam welding-Ultrasonic welding- Plasma arc welding

MODULE 5 (9 hours)

Welding of dissimilar metals- Joining of ferrous and non-ferrous metals, Polymers- Advances in brazing and soldering. Weld joint inspection methods- - Destructive and non-destructive testing of welds. Weld Distortion- Residual stresses and their measurement methods. Solidification of weld metal - Distinct zones in a weld - Nucleation - Epitaxial growth - Competitive growth - CAE in welding: Introduction to simulation tools in welding.

Text Books

1. Materials Selection in Mechanical Design Fourth Edition Michael F. Ashby.

2. Mechanical Metallurgy , George Ellwood Dieter ,McGraw-Hill, 1988.

Reference Books

1. Materials Science and Engineering: An Introduction, William D. Callister Jr. and David G. Rethwisch John Wiley & Sons

2. Elements of X-Ray Diffraction B.D. Cullity S.R. Stock Third Edit. Pearson Education Limited

3. Scanning Electron Microscopy and X-Ray Microanalysis: Joseph I. Goldstein, Dale E. Newbury, Joseph R. Michael, Nicholas W.M. Ritchie, John Henry J. Scott, David C. Joy, 4th Edition, Springer 2017

4. Differential thermal analysis and differential scanning calorimetry. In: Thermal Methods of Analysis. Haines, P.J., Wilburn, F.W. (1995). Springer

5. Superplasticity Common Basis for a Near-Ubiquitous Phenomenon ,K. A. Padmanabhan, S. Balasivanandha Prabu ,R. R. Mulyukov , Ayrat NazarovR. M. Imayev ,S. Ghosh Chowdhury , Springer

6. Biomaterials: Design, Development and Biomedical Applications. Raghavendra, G M & Varaprasad, Kokkarachedu & Jayaramudu, Tippabattini. (2015). 10.1016/B978-0-323-32889-0.00002-9.

7. Biomaterials an Introduction, Third Edition, Springer

8. Textbook of Nanoscience and Nanotechnology , .S. Murty · P. Shankar Baldev Raj · B B Rath · James Murday, Springer, Berlin, Heidelberg

9. Modern Ceramic Engineering Properties, Processing, and Use in Design Fourth Edition,David W. Richerson, William E. Lee, CRC Press Taylor & Francis Group

COURSE CONTENTS AND LECTURE SCHEDULE

(For 4 credit courses, the content can be for 45 hrs. and for 3 credit courses, the content can be for 36 hrs.)

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Investment casting- Shell moulding	2
1.2	Squeeze casting- plaster-mould and ceramic-mould casting	1
1.3	high-pressure die casting – lost foam process -Centrifugal casting	2
1.4	the casting of metal matrix composites and functionally graded metal matrix composites	3
2	**Module 2**	
2.1	Directional and monocrystal solidification - Semisolid metal casting- Rheocasting	2
2.2	Mechanism of solidification in metals and alloys- Nucleation and grain growth- Dendritic growth	2
2.3	Casting economics	2
3	**Module 3**	
3.1	Design of gating systems	4
3.2	Ferrous and non-ferrous materials used in casting	1
3.3	Defects in castings- Inspection of castings	2
3.4	CAE in casting: Introduction to simulation tools in casting.	1
4	**Module 4**	

4.1	Review of welding processes- Process selection- Types of weld joints	1
4.2	Weldability	2
4.3	Laser Beam Welding: Types of lasers- Equipment- Power calculation- Applications- Dual laser beam welding	2
4.4	Friction stir welding- Electron beam welding	2
4.5	Ultrasonic welding- Plasma arc welding	2
5	**Module 5**	
5.1	Welding of dissimilar metals- Joining of ferrous and non-ferrous metals, Polymers	2
5.2	Advances in brazing and soldering.	1
5.3	Weld joint inspection methods- - Destructive and non-destructive testing of welds.	1
5.4	Weld Distortion- Residual stresses and their measurement methods.	2
5.5	Solidification of weld metal - Distinct zones in a weld - Nucleation - Epitaxial growth - Competitive growth	2
5.6	CAE in welding: Introduction to simulation tools in welding.	1

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1T102**

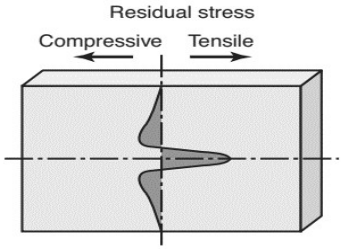
Course Name: **ADVANCED WELDING AND CASTING**

Max. Marks:60 Duration: 3 hours

Part A

(Answer all questions. Each question carries 5 marks).

1. A true centrifugal casting operation is to be performed horizontally to make copper tube sections with an outside diameter of 30 cm and an inside diameter of 28 cm. What rotational speed is required if a G-factor of 65 is used to cast the tubing?
2. 125 kg of aluminium is to be heated to a pouring temperature of 800°C. The unit melting and pouring energy of the metal = 1035 J/g. Thermal efficiency of the furnace = 50%. How much time is required to heat the metal from 25°C to the pouring temperature if the electric induction furnace generates 175 kW?
3. Calculate the optimum pouring time for a casting whose mass is 30 kg and has an average section thickness of 25 mm. The materials of the casting are grey cast iron and steel. Take the fluidity of iron as 28 inches.
4. A gas tungsten arc-welding operation is performed at a current of 350 A and voltage of 25 V. The heat transfer factor $f_1 = 0.80$, melting factor $f_2 = 0.55$, and unit melting energy for the metal $U_m = 15$ J/mm^3. Determine the (a) power in the operation, (b) rate of heat generation at the weld, and (c) volume rate of metal welded.
5. In Fig. shown below, assume that most of the top portion of the top piece is cut horizontally with a sharp saw. The residual stresses will now be disturbed, and the part will change its shape. For this case, how do

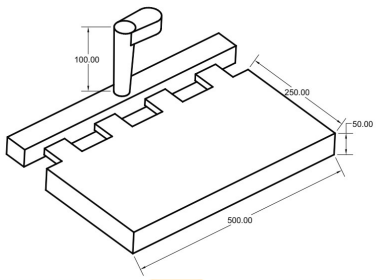


you think the part will distort: curved downward or upward? Explain.

Part B

(Answer Any five questions. Each question carries 7 marks)

1. Illustrate and explain shell moulding. What is the shell sand composition for low carbon steel?
2. Explain microscopic and macroscopic level segregation during the solidification of an alloy.
3. For the casting shown in Fig., which is to be made in cast iron, calculate the choke area.



4. What are the main issues related to laser welding? List the laser welding characteristics for Aluminium alloys, steels, titanium alloys, and Iridium alloys
5. Explain and illustrate epitaxial nucleation and competitive growth.
6. Calculate the size of a cylindrical riser (height and diameter equal) necessary to feed a steel slab casting 30 x 30 x 5 cm, with a top riser casting poured horizontally into the mould.
7. Explain Ultrasonic welding. Differentiate between US rollerand US spot welding with sketches.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1T103	APPLIED MATERIALS ENGINEERING	Core	3	0	0	3	3

Preamble: This subject explores the principles and applications of materials in various engineering fields. This course provides students with a comprehensive understanding of the behavior, selection, processing, and performance of materials used in engineering applications. Through a combination of lectures, laboratory experiments, and projects, students will gain practical experience in analyzing, designing, and selecting materials for specific engineering tasks.

Prerequisite:

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

CO no.	Course Outcome statements	Cognitive Knowledge level
CO 1	Analyse a materials design problem to select materials and suitable geometry	Apply
CO 2	Understand the principles of optical microscopy, SEM, and thermo mechanical analysis	Apply
CO 3	Analyze the mechanism of superplasticity in low melting point metals and alloys and Analyse the suitability of materials to be used in biomedical applications	Understand
CO 4	Categorize nanomaterials based on structure and analyse the properties of nanomaterials with respect to changes in dimensions	Apply
CO 5	Correlate the atomic bonding, crystal structure and defect formation with properties of ceramics	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		3	3	3	3
CO 2	3		2		2	2
CO 3	3		2	2		2
CO 4	3		2	2	2	2
CO 5			2		2	

Assessment Pattern

Bloom's Category	APPLIED MATERIALS ENGINEERING		
	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	25	25	25
Understand	15	15	15
Apply	30	25	30
Analyse	10	10	10
Evaluate	10	15	10
Create	10	10	10

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 H

SYLLABUS

MODULE 1 (9 hours)

Types of design, Design tools and materials data –Technologically important properties of materials - Physical, chemical, mechanical, thermal, optical, environmental and electrical properties of materials. Material property charts - Modulus – density, strength-density, fracture toughness-strength Materials and shape – microscopic shape factors – limit to shape efficiency case studies -Mirrors for Large Telescopes `-Materials for Springs - Materials for Flywheels

MODULE 2 (9 hours)

Review of Purpose and importance of destructive tests – Concepts, and method of Tensile, hardness, bend, torsion, fatigue and creep testing.

Tools of characterisation - X-ray diffraction and its applications in materials characterization. Light microscopy, basic principles and special techniques. Electron microscopy, Construction, operation and applications of scanning electron microscope (SEM),

Thermal methods: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetry & dilatrometry.

MODULE 3 (7 hours)

Superplasticity – Introduction - structural superplastiocity – environmental superplasticity – Mechanism – Testing - plastic instability - neck formation - low melting point alloys and superplasticity

Biomaterials: Introduction to biomaterials – preparation, hydrogel biomaterials – biocompatibility – biomaterial implantation – biomaterials for medical applications

MODULE 4 (7 hours)

Introduction to nanotechnology, Classifications nanoparticles and their properties: optical, electronic, magnetic properties; Application:

MODULE 5 (9 hours)

Ceramics: classification of ceramics, bonding and structure of various ceramic materials; crystal structure and defects; polymorphic transformations

Text Books

1. Materials Selection in Mechanical Design Fourth Edition Michael F. Ashby.

2. Mechanical Metallurgy , George Ellwood Dieter ,McGraw-Hill, 1988

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Reference Books

1. Materials Science and Engineering: An Introduction, William D. Callister Jr. and David G. Rethwisch John Wiley & Sons
2. Elements of X-Ray Diffraction B.D. Cullity S.R. Stock Third Edit. Pearson Education Limited
3. Scanning Electron Microscopy and X-Ray Microanalysis: Joseph I. Goldstein, Dale E. Newbury, Joseph R. Michael, Nicholas W.M. Ritchie, John Henry J. Scott, David C. Joy, 4th Edition, Springer 2017
4. Differential thermal analysis and differential scanning calorimetry. In: Thermal Methods of Analysis. Haines, P.J., Wilburn, F.W. (1995). Springer
5. Superplasticity Common Basis for a Near-Ubiquitous Phenomenon ,K. A. Padmanabhan, S. Balasivanandha Prabu ,R. R. Mulyukov , Ayrat NazarovR. M. Imayev ,S. Ghosh Chowdhury , Springer
6. Biomaterials: Design, Development and Biomedical Applications. Raghavendra, G M & Varaprasad, Kokkarachedu & Jayaramudu, Tippabattini. (2015). 10.1016/B978-0-323-32889-0.00002-9.
7. Biomaterials an Introduction, Third Edition, Springer
8. Textbook of Nanoscience and Nanotechnology , .S. Murty · P. Shankar Baldev Raj · B B Rath · James Murday, Springer, Berlin, Heidelberg
9. Modern Ceramic Engineering Properties, Processing, and Use in Design Fourth Edition,David W. Richerson, William E. Lee, CRC Press Taylor & Francis Group.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours : 40
	MODULE 1 (9 hours)	
1.1	The design process-types of design-design tools and material data-Interaction between function material shape and process	1
1.2	Stress-strain curve for metal, ceramic and polymer -modulus of rupture - hardness – fracture toughness-loss coefficients-thermal conductivity-electrical resistivity -dielectric loss-optical properties	1
1.3	The Material Property Charts The modulus–density chart- The strength–density chart The modulus–strength chart The specific stiffness–specific strength chart -The fracture toughness–modulus chart - The fracture toughness–strength chart - The loss coefficient–modulus chart . The thermal conductivity–electrical resistivity chart - The maximum service temperature chart - Friction and wear- Cost bar charts. The modulus–relative cost chart - The strength–relative cost chart	2

1.4	Material election - stages - attributes - material indices - selection procedure-case studies- Mirrors for Large Telescopes `-Materials for Springs -Materials for Flywheels	1
1.5	Shape factors-bending of beams-twisting of shafts-limits to shape efficiency-material indices for bending of beams and twisting of shafts-microscopic shape factors-case studies	1
	MODULE 2 (9 hours)	
2.1	Purpose and importance of destructive tests – Concepts, and method of Tensile, hardness, bend, torsion, fatigue and creep testing.	1
2.2	Introduction to microscopy: Basic principles of image formation - General concepts of microscopy: resolution. Magnification, depth of field, depth of focus etc. image formation, contrast development-Basic components (light sources, specimen stage, lens system, optical train etc.)	1
2.3	X-ray production-Electromagnetic radiation, continuous spectrum, characteristic spectrum-X-ray absorption (adsorption edge, excitation voltage, Auger effect etc.), X-ray filters- Intensities of diffracted beams-Scattering by single electron (Thomson and Crompton scattering)Scattering by single atom: atomic scattering factorIntensities of diffracted beamsScattering from unit cell: structure factor calculation for various crystal systems Multiplicity factor and temperature factor Braggs law-Rotating crystal method-powder method,Laue method	2
2.4	SEM-Working principle in scanning mode- Signal generation: Inelastic scattering (Secondary vs. backscattered electron, Auger electrons, characteristic X-ray emission etc.) Basic components of SEM :Detectors: SE (E-T detector), BSE (scintillator vs. solid state), in-lense detector Optics of SEM (magnification, pixel, resolution, depth of field) Resolution in SEM (minimum probe size, beam current etc.) Chemical analysis in SEM- EDS and WDS detectors-Imaging and contrast generation in SEM-Topographic imaging (in SE & BSE mode)-Compositional imaging (BSE mode)	3
2.5	Thermal gravimetric analysis-Differential thermal analysis (DTA) differential scanning calorimetry & dilatrometry	2
	MODULE 3 (7 hours)	
3.1	Introduction - super plasticity testing methods - compression test - tension test-torsion test-indentation test-measurement of internal stress and grain boundary shear-damping characteristics-strain rate sensitivity –plastic instability (constitutive equations not required)	2
3.2	Superplasticity in magnesium alloys-grain refinement-characterisation of super plastic flow behaviour-processing routes	2
3.3	Introduction to biomaterials – Preparation - hydrogel biomaterials – biocompatibility – biomaterial implantation – biomaterials for medical applications	3
	MODULE 4 **(7 hours)**	

4.1	Classification of nanostructured materials-applications of nanomaterials	3
4.2	Microstructure and Defects in Nanocrystalline Materials-Effect of Nano-dimensions on Materials Behaviour	4
	Module 5 (9 hours)	
5.1	Definition of ceramics- Electronic configuration of atoms-bonding-polymorphic forms and transformations	2
5.2	Non crystalline structures- molecular structures	1
5.3	Crystal Chemistry of ceramics-ionic radius-ionic packing –effect of charge	1
5.4	Ordering-non stoichometry-Binary ceramic structures- Ternary Structures-carbide and nitride structures-	3
5.5	Crystal defects and stoichometry	1

Model Question Paper

QP CODE: Pages: 2

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

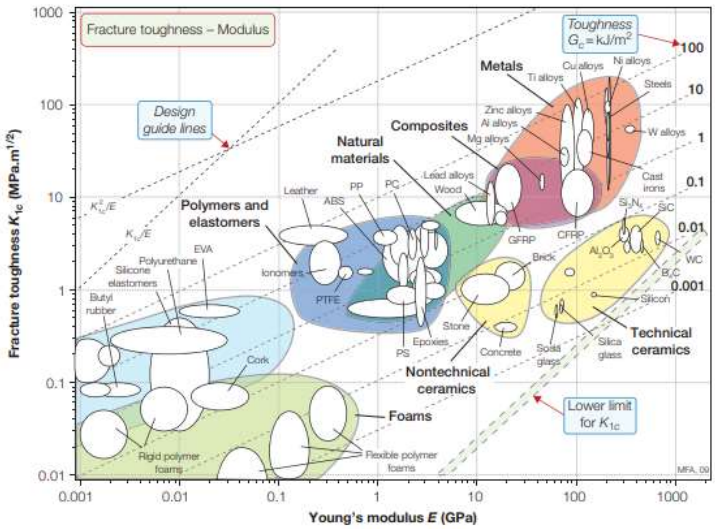
FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1T103**

Course Name: APPLIED MATERIALS ENGINEERING

Max. Marks:60 Duration: **2½ hours**

PART A

	PART A (Answer all the five questions from Part A)	
	Module 1	
1.	Using the KIc –E chart given compare the fracture toughness of common polymers polycarbonate, ABS, or polystyrene  	5 marks
	Module 2	
2.	Explain the factors that affect the characteristics of X Rays	5 marks
	Module 3	

3.	Discuss why strain rate sensitivity index is not considered as a material constant.	5 marks
	Module 4	
4.	Discuss the stability of dislocations and disclinations in nanocrystalline materials.	5 marks
	Module 5	
5.	Identify two types of polymorphic transformation.	5 marks
	PART B (Answer any five questions from Part B)	
1.	A beam, loaded in bending, must support a specified bending moment M* without failing and be as light as possible. Section shape is a variable, and "failure" here means the first onset of plasticity. Derive the material index. The following table summarizes the requirements. Function Lightweight beam Constraints Specified failure moment M* Length L specified Objective Minimum mass m Free variables Choice of material Section shape and scale	7 marks
2.	Compare the stress strain curves for ductile, brittle and polymer material	7 marks
3.	Describe the role of electrons in SEM	7 marks
4.	Describe a method for producing large sheets of ultrafine-grained magnesium alloys	7 marks
5.	Examine the properties of 316L type stainless steel to be used as biomedical implants	7 marks
6.	The hardness of Fe is 4 and 6 GPa at 80 and 60 nm, respectively. Assuming that the Hall–Petch relation is valid, calculate the hardness of Fe with a grain size of 7 nm	7 marks
7.	Describe at least two structural similarities of diamond, silicon carbide, and silicon nitride	7 marks
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Programme Elective 1

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E104A	**QUALITY ENGINEERING AND MANAGEMENT**	Elective	3	0	0	3	3

Preamble :

This course helps the students to understand the philosophy and core values of quality management. The course also covers quality management principles, frameworks, tools and techniques for effective real life applications in industry and also the different methods for improving quality.

Prerequisite : NIl

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

Co No.	Course Outcome Statements	Cognitive Knowledge level
CO 1	Develop an understanding on quality management philosophies and frameworks	Apply
CO 2	Develop in-depth knowledge on various tools and techniques of quality management	Apply
CO 3	Learn the applications of quality tools	Understand
CO 4	Learn techniques in both manufacturing and service industry	Apply
CO 5	To aware about quality systems and standards	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	2	2			2
CO 2	1	2	2	2	2	2
CO 3	1	2	2	3	3	2
CO 4	1	2	2	3	3	2
CO 5	1	2	2			1

Assessment Pattern

Course name	QUALITY ENGINEERING AND MANAGEMENT		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	20	20	20
Understand	20	20	20
Apply	20	20	20
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	10

Mark distribution

Total Marks	**CIA marks**	**ESE marks**	**ESE Duration**
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (6 hours)

Introduction to Quality: Definitions of quality, Philosophies of quality 'gurus', Dimensions of quality, Measures of quality, Cost associated with quality, Direct costs & indirect costs of quality, Defects and Defectives, Traditional model and emerging Model of 'cost-of-quality.'

MODULE 2 (8 hours)

Continuous process improvement: PDCA cycle, PDSA cycle, Problem solving methodology Statistical process control: Statistical Process Control tools, Control charts for Variables, Control charts for Attributes, Process capability, Problems

MODULE 3 (8 hours)

Acceptance sampling: Lot-by-lot acceptance sampling by attributes, Fundamental concepts, Statistical aspects: Operating characteristic curve, Producer's risk and Consumer's risk, AQL, LQ, AOQ, ASN, ATI, Sampling plan design

MODULE 4 **(8 hours)**

Taguchi's Quality Engineering: Loss functions, Signal-to-noise ratio, Process optimization and robust product design using orthogonal arrays, Parametric and Tolerance design Quality function deployment: Concept, House of quality, QFD process

MODULE 5 (6 hours)

Total quality management (TQM): Definition, Basic concepts, Strategies , Six sigma methodology: Basic concepts, DMAIC problem solving technique ,Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards

Text Books

1. Besterfield, D. H., "Quality control", Pearson Education, New Delhi, 2006.
2. Besterfield D. H., Besterfield, C., Besterfield, G. H. & Besterfield, M., "Total Quality Management", Pearson Education, New Delhi, 2008.

Reference Books

1. Subburaj, R., "ISO 9000: Path to TQM", Allied Publishers Limited, New Delhi, 1997
2. Bank J., "The essence of total quality management", Prentice Hall
3. Dale B. G., "Managing quality", Prentice Hall

4. Feigenbaum, A. V., "Total quality control", McGraw Hill

5. Taguchi G. L. and Syed et. al., "Quality engineering production systems", McGraw Hill

6. Zaidi, "SPC - concepts, methodology and tools", Prentice Hall

7. Johnson, P. L., "ISO 9000", McGraw Hill

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. Of Lectures
1	**Module 1: Introduction to Quality**	**6 hrs**
1.1	Introduction to Quality: Definitions of quality, Philosophies of quality 'gurus', Dimensions of quality, Measures of quality, Cost associated with quality, Direct costs & indirect costs of quality, Defects and Defectives, Traditional model and emerging Model of 'cost-of-quality.'	6 hrs
2	**Module 2: Continuous Process Improvement and Statistical Process Control**	**8 hrs**
2.1	Continuous process improvement: PDCA cycle, PDSA cycle, Problem solving methodology	2 hrs
2.2	Statistical process control: Statistical Process Control tools, Control charts for Variables, Control charts for Attributes, Process capability, Problems	6 hrs
3	**Module 3: Acceptance Sampling**	**8 hrs**
3.1	Acceptance sampling: Lot-by-lot acceptance sampling by attributes, Fundamental concepts, Statistical aspects: Operating characteristic curve, Producer's risk and Consumer's risk, AQL, LQ, AOQ, ASN, ATI, Sampling plan design	8 hrs
4	**Module 4: Taguchi's Quality Engineering and Quality Function Deployment**	**8 hrs**
4.1	Taguchi's Quality Engineering: Loss functions, Signal-to-noise ratio, Process optimization and robust product design using orthogonal arrays, Parametric and Tolerance design	5hrs
4.2	Quality function deployment: Concept, House of quality, QFD process	3 hrs
5	**Module 5: TQM, Six Sigma, Quality System and Standards**	**6 hrs**
5.1	Total quality management (TQM): Definition, Basic concepts, Strategies	2 hrs

5.2	Six sigma methodology: Basic concepts, DMAIC problem solving technique	2 hrs
5.3	Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards	2 hrs

CO ASSESSMENT QUESTIONS Course

Outcome 1 (CO1):

1. Discuss about major quality gurus and their philosophies.

2. Explain about dimensions of quality in detail.

3. Differentiate between PDCA and PDSA cycles.

Course Outcome 2 (CO2)

1. Explain the basic concept of Six Sigma.

2. Explain the major tools used for statistical process control.

3. Explain the steps for constructing a House of Quality with an example.

Course Outcome 3 (CO3)

1. Construct a control chart for given example.

2. Construct an OC curve for given example.

3. Explain parametric design with a suitable example.

Course Outcome 4 (CO4)

1. What do you mean by quality system?

2. Differentiate between ISO 12000 and ISO 9000.

3. Explain ISO 9000 in detail.

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM
FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E104A**

Course Name: **QUALITY ENGINEERING AND MANAGEMENT**

Max. Marks:60 Duration: 3 hours

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain about dimensions of quality.
2. Differentiate between PDCA and PDSA cycle.
3. Define AQL, LQ, AOQ, ASN and ATI.
4. Explain about different types of Loss functions.
5. Differentiate between ISO9000 and ISO12000.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Differentiate between Traditional model and emerging Model of cost-of-quality.
7. Explain different types of control charts for variables in detail.
8. Explain different types of control charts for attributes in detail.
9. Explain about the Operating Characteristic curve with a neat graph.
10. Explain the steps of constructing a House of Quality with suitable examples.
11. Discuss about the QFD process in detail.

12. Explain about DMAIC problem solving methodology in detail.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E104B	COMPUTER AIDED MANUFACTURING	Elective	3	0	0	3	3

Preamble: This course helps the students to understand the design features of CNC machines and their control systems. The course also covers the part programming for CNC lathe and machine center.

Prerequisite **:** Nil

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

Co No.	Course outcomes statements	Cognitive knowledge level
CO 1	Basic understanding of the design features of CNC machines	Apply
CO 2	The ability to generate part programs to machine parts to specifications in CNCss	Apply
CO 3	The ability to generate part programs to machine parts to specifications in machining centers	Apply
CO 4	Basic understanding of control system and interfacing of CNC machines	Understand
CO 5	To familiar with fundamentals of CAM packages	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	2			
CO 2	1	1	2	3	3	1
CO 3	1	1	2			
CO 4	1	1	2			
CO 5	1	1	2			

Assessment Pattern

Course name	COMPUTER AIDED MANUFACTURING		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	20	20	20
Understand	20	20	20
Apply	20	20	20
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	10

Mark distribution

Total Marks	**CIA marks**	**ESE marks**	**ESE Duration**
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (6 hours)

Introduction to CNC machines: Working principles of typical CNC lathes, Turning center, Machining center, CNC grinders, CNC gear cutting machines, Wire cut EDM, Turret punch press, CNC press brakes etc. Selection of CNC machine tools..

MODULE 2 (6 hours)

Design features of CNC machines: Structure, Drive kinematics, Gear box, Main drive, Feed drive, Selection of timing belts and pulleys, Spindle bearings arrangement and installation, Recirculating ball screws, Linear motion guideways, Tool magazines, ATC, APC, Chip conveyors, Tool turrets, Pneumatic and hydraulic control systems.

MODULE 3 (8 hours)

Control systems and interfacing: Open loop and closed loop systems, Microprocessor based CNC systems, Block diagram of a typical CNC system, Description of hardware and software interpolation systems, Standard and optional features of a CNC control system, Comparison of Different control systems, Feedback devices with a CNC system, Spindle Encoder.

MODULE 4 **(8 hours)**

Part programming of a CNC lathe: Process planning, Tooling, Preset and qualified tools, Typical tools for turning and machining centers, Axes definition, Machine and workpiece datum, Turret datum, Absolute and incremental programming, Tape codes , ISO and EIA codes, G and M functions, Tool offset information, Soft jaws, Tool nose radius compensation, Long turning cycle, Facing cycle, Constant cutting velocity, Threading cycle, peck drilling cycle, Part programming examples.

MODULE 5 (8 hours)

Manual part programming of a machining center: Coordinate systems, Cutter diameter compensation, Fixed cycles, Drilling cycle, Tapping cycle, Boring cycle, Fine boring cycle, Back boring cycle, Area clearance programs, Macros, Parametric programming, Part programming examples, CAD/CAM based NC programming, Features of typical CAM packages.

Text Books

1. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996

2. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990.

Reference Books

1. Berry Leathan - Jones, “Introduction to computer numerical control”, Pitman, London, 1987
2. Hans B. Kief, T. Frederick Waters, “Computer numerical control”, MacMillan / McGraw-Hill, 1992
3. Bernard Hodgers, “CNC part programming work book”, City and Guilds / Macmillan, 1994.
4. David Gribbs, “An introduction to CNC machining”, Cassell, 1987
5. Sadasivan, T. A. and Sarathy, D., “Cutting tools for productive machining”, Widia (India) Ltd., 1999
6. Radhakrishnan, P., “Computer numerical control machines”, New Central Book Agency, 1992
7. Peter Smid, “CNC programming handbook”, Industrial Press Inc., 2000

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. Of Lectures
1	**Module 1: Introduction to CNC Machines**	**6 hrs**
1.1	Introduction to CNC machines: Working principles of typical CNC lathes, Turning center, Machining center, CNC grinders, CNC gear cutting machines, Wire cut EDM, Turret punch press, CNC press brakes etc. Selection of CNC machine tools.	6 hrs
2	**Module 2: Design features of CNC Machines**	**6 hrs**
2.1	Design features of CNC machines: Structure, Drive kinematics, Gear box, Main drive, Feed drive, Selection of timing belts and pulleys, Spindle bearings arrangement and installation, Recirculating ball screws, Linear motion guideways, Tool magazines, ATC, APC, Chip conveyors, Tool turrets, Pneumatic and hydraulic control systems.	6 hrs
3	**Module 3: Control Systems and Interfacing**	**8 hrs**

3.1	Control systems and interfacing: Open loop and closed loop systems, Microprocessor based CNC systems, Block diagram of a typical CNC system, Description of hardware and software interpolation systems, Standard and optional features of a CNC control system, Comparison of Different control systems, Feedback devices with a CNC system, Spindle Encoder.	8 hrs
4	**Module 4: Part Programming of a CNC Lathe**	**8 hrs**
4.1	Part programming of a CNC lathe: Process planning, Tooling, Preset and qualified tools, Typical tools for turning and machining centers, Axes definition, Machine and workpiece datum, Turret datum, Absolute and incremental programming, Tape codes , ISO and EIA codes, G and M functions, Tool offset information, Soft jaws, Tool nose radius compensation, Long turning cycle, Facing cycle, Constant cutting velocity, Threading cycle, peck drilling cycle, Part programming examples.	8hrs
5	**Module 5: Manual Part Programming of a Machine Center**	**8 hrs**
5.1	Manual part programming of a machining center: Coordinate systems, Cutter diameter compensation, Fixed cycles, Drilling cycle, Tapping cycle, Boring cycle, Fine boring cycle, Back boring cycle, Area clearance programs, Macros, Parametric programming, Part programming examples, CAD/CAM based NC programming, Features of typical CAM packages.	8 hrs

CO ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Explain about selection of timing belts and pulleys in CNC machines.

2. Discuss about ATC and APC.

3. Discuss about drive kinematics in CNC machines.

Course Outcome 2 (CO2)

1. Explain about G and M functions in detail.

2. Differentiate between absolute and incremental part programming.

3. Explain about parametric programming in detail.

Course Outcome 3 (CO3)

1. Explain about feedback devices with a CNC system.

2. Differentiate between open loop and closed loop systems.

3. Differentiate between pneumatic and hydraulic control systems.

Course Outcome 4 (CO4)

1. Explain Features of typical CAM packages..

2. List down different CAM packages.

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E104B**

Course Name: **COURSE NAME**
COMPUTER AIDED MANUFACTURING

Max. Marks:60 Duration: 3 hours

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain the working principle of typical CNC lathe.
2. Explain about recirculating ball screws.
3. Differentiate between open loop and closed loop control systems.
4. Differentiate between absolute and incremental programming.
5. List out the features of typical CAM packages.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Explain about Wire cut EDM with a neat sketch.
7. Differentiate between hydraulic and pneumatic control systems.
8. Explain about microprocessor based CNC systems in detail.
9. Explain about typical tools for turning and machining centers in detail.
10. Explain about different types of coordinate systems used in part programming.
11. Explain about CNC grinders with a neat sketch.
12. Differentiate between ATC and APC.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E104C	Design of Machine Tool Systems	Elective	3	0	0	3	3

Preamble : This course provides a comprehensive exploration of the design principles and methodologies essential for developing advanced machine tool systems. Students will gain an in-depth understanding of the various types of machine tools, their components, and the design considerations necessary for optimizing their performance and functionality. The curriculum emphasizes the integration of mechanical, electrical, and control systems to achieve precision, efficiency, and reliability in machine tool operations

Prerequisite : NIL

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

CO no.	Course outcome statements	Cognitive Knowledge level
CO 1	Illustrate machine tool design process	Apply
CO 2	Analyse kinematic motions in machine tools and Design of speed and feed gear boxes	Apply
CO 3	Design of machine tool structures, guideways and power screws	Apply
CO 4	Design of spindles and spindle supports	Apply
CO 5	Evaluate various control systems in machine tools	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	2	3	3	1
CO 2	3	1		3	2	
CO 3	3			3		
CO 4	3			3		
CO 5	3		2	3	3	

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	60	60	60
Understand	15	15	15
Apply	15	15	15
Analyse	10	10	10
Evaluate	0	0	0
Create	0	0	0

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

Module-1

Classifications of machine tools-Construction features and operations- Surfaces, profiles and path produced by machine tools- General requirement of machine tool design- Machine tool design processes- Working and auxiliary motions in machine tools-Drives in Machine Tool tools

Module-2

Stepped regulation of speeds – Laws of stepped regulation-Multiple speed motors - Ray diagrams and design considerations - Design of speed gear boxes-Design of Feed box-Stepless regulations of speed and feed rates

Module-3

Design of machine tool structures-Design criteria for machine tool structures-Basic design procedure for machine tool structures-Design of beds, housings, columns and tables-Design of guideways for stiffness and wear resistance-Design of aerostatic slide ways and design of antifriction guide ways-Design of power screws

Module-4

Functions of spindle unit and Requirements-Effect of machine tool compliance on machining accuracy-Design of spindles and antifriction bearings-General procedure for assessing dynamic stability of Cutting process - Dynamic characteristics of elements and systems-Chatters in machine tools

Module-5

Control system in machine tools-Basic elements, Functions and requirements of control system-Types of machine tool controls-Control systems for speed and feed change-Adaptive control system-Acceptance tests for machine tools- new concepts in Machine tool design

Text Books

1. Machine tool design and numerical control, N K Mehta, TMH, New Delhi.2010
2. Principles of Machine tools, G C Sen and A Bhattacharya, New central book agency,2009

Reference Books

1. Design of machine tools, D K Pal, S K Basu,5th edition Oxford IBH,2008
2. Design principles of metal cutting machine tools, A. Koenigsburger, Pergaman press,1964

COURSE CONTENTS AND LECTURE SCHEDULE

(For 4 credit courses, the content can be for 45 hrs. and for 3 credit courses, the content can be for 36 hrs.)

No	Topic	No. of Lectures
1.1	Classifications of machine tools-Construction features and operations	1
1.2	Surfaces, profiles and path produced by machine tools	1
1.3	General requirement of machine tool design	1
1.4	Machine tool design processes	1
1.5	Working and auxiliary motions in machine tools	1
1.6	Drives in Machine Tool tools	2
2.1	Stepped regulation of speeds, Laws of steeped regulation	1
2.2	Multiple speed motors	1
2.3	Ray diagrams and design considerations	2
2.4	Design of speed gear boxes	2
2.5	Design of Feed box	1
2.6	Stepless regulations of speed and feed rates	2
3.1	Design of machine tool structures	2
3.2	Design criteria for machine tool structures	1
3.3	Basic design procedure for machine tool structures	2
3.4	Design of beds, housings, columns and tables	2
3.5	Design of guideways for stiffness and wear resistance	1
3.6	Design of aerostatic slide ways and design of antifriction guide ways	1

3.7	Design of power screws	1
4.1	Functions of spindle unit and Requirements	1
4.2	Effect of machine tool compliance on machining accuracy	1
4.3	Design of spindles and antifriction bearings	2
4.4	General procedure for assessing dynamic stability of Cutting process	1
4.5	Dynamic characteristics of elements and systems	1
4.6	Chatters in machine tools	1
5.1	Control system in machine tools	1
5.2	Basic elements, Functions and requirements of control system	1
5.3	Types of machine tool controls	1
5.4	Control systems for speed and feed change	1
5.5	Adaptive control system	1
5.6	Acceptance tests for machine tools	1
5.7	New concepts in Machine tool design	1

CO ASSESSMENT

QUESTIONS

Course Outcome 1 (CO1):

1. Summarize the types of surfaces, profiles and paths produced by machine tools

2.Explain the general requirements of machine tool design

Course Outcome 2 (CO2)

1. Compare various types of differential mechanism

2. Explain the function of direction-control valve in hydraulic transmission system

Course Outcome 3(CO3):

1. Categorize various laws of stepped regulation

2. Develop the rpm values of spindle constitute on arithmetic progression

Course Outcome 4 (CO4):

1. Explain basic design procedure of machine tool structure

2.Analyze various shape of slideways applicable to machine tool

Course Outcome 5 (CO5):

1. Elaborate the general procedure for assessing the dynamic stability of cutting process Discuss the design calculation of spindles

2. Explain the design calculations of spindles

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E104C**

Course Name:**Design of Machine Tool Systems**

Max. Marks:60 Duration: 3 hours

Answer all five questions. Part 'A' of each question is compulsory.

Answer any five questions from Part 'B'

Q No.	Part-A	Max Marks
1.	Explain the general requirements of machine tool design	5
2.	Compare various types of differential mechanism	5
3.	Explain basic design procedure of machine tool structure	5
4.	Elaborate the general procedure for assessing the dynamic stability of cutting process Discuss the design calculation of spindles	5
5.	Explain adaptive control systems used in machine tool	5

Q No.	Part-B	Max Marks
6.	Illustrate the function of direction-control valve in hydraulic transmission system	7
7.	Explain the basic consideration in design of drives	7
8.	Develop the rpm values of spindle constitute on arithmetic progression	7
9.	Design a gear box of turret lathe having a reduction of speeds from 25 to 800 rpm. the drive consists of AC motor having speed of 2000 rpm. Arrange the speed in geometric progression	7
10.	Analyze various shape of slideways applicable to machine tool	7
11.	Explain the design calculations of spindles	7
12.	Explain the systematic procedure for performing acceptance tests	7

Programme Elective 2

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E105A	Robotics and Automation	Elective	3	0	0	3	3

Preamble : This course offers an in-depth examination of robotics and automation technologies, focusing on their principles, design, and applications in modern industrial settings. Students will explore the fundamentals of robotic systems, including kinematics, dynamics, and control, as well as automation technologies that enhance productivity and efficiency in manufacturing processes

Prerequisite : Nil

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

CO no.	Course Outcomes Statements	Cognitive knowledge level
CO 1	Describe robot specifications, configurations and joint transformations.	Apply
CO 2	Explain the concept of inverse kinematics and workspace analysis.	Apply
CO 3	Describe dynamics of robotic motion, task planning and its control.	Apply
CO 4	Select suitable drives and sensors for its control.	Understand
CO 5	Describe various aspects of industrial automation.	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		2	3	3	
CO 2	3		2	3	3	
CO 3	3		2	3	3	
CO 4	3		2	3	3	
CO 5	3		2	3	3	

Assessment Pattern

Course name	Robotics and Automation		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	20	20	20
Understand	20	20	20
Apply	20	20	20
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	10

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

Module 1:

Robot classification: Drive technologies, Work-envelope geometries, Motion control methods.

Robot Specification: Number of axes, Capacity and speed, Reach and stroke, Tool orientation, Repeatability, precision and accuracy, operating environment.

Direct Kinematics: Coordinate frames, Rotations, Homogeneous coordinates, Link coordinates, D-H parameters, arm equation.

Module 2:

Inverse kinematics: Inverse kinematics problem, General properties of solutions, Tool configuration, Existence and uniqueness of solutions, solutions for 3,4,5 and 6 axes robots.

Workspace analysis: Workspace fixtures, pick and place operation, continuous path motion, interpolated motion, straight line motion

Differential motion and statics: Manipulator Jacobian, Jacobian inverse, Jacobian singularities, Static analysis.

Module 3:

Manipulator dynamics: Lagrange equation, Kinetic and potential energy, generalized force, Lagrange-Euler dynamic model.

Trajectory planning and generation: Definitions and planning tasks, Joint space techniques, Cartesian space techniques, Joint-Space versus Cartesian Space trajectory planning.

Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control.

Module 4:

Drives for robots:

Hydraulic Drives: Requirements, Hydraulic components in robots; Pneumatic Drives: Components used in pneumatic control; Electric Drives: Introduction, DC & AC electric motors, stepper motors, Servo motors.

Sensors in Robotics: Position sensors-optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors-Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque sensors, Temperature, Humidity, Light sensors.

Module 5 :

Robot vision: Vision Sensors, Robot Control through Vision sensors, Robot vision locating position, Robot guidance with vision system.

Industrial Automation: Automation principles and strategies, automated flow lines, Transfer mechanisms, Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Line balancing, Automated Materials Handling: Material Handling Equipment, Conveyor Systems, Automated Guided Vehicle Systems, Automated Inspection and Testing: Principles and Methods.

Text Books

1. John J Craig, “Introduction to Robotics”, Pearson, Academic Press, 3rd Edition, 2004.
2. D Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003.
3. Frank Lamb, “Industrial Automation: Hands On”, McGraw-Hill, 2013.
4. P.A. Janaki Raman, “Robotics and Image Processing: An Introduction”, TMH Publishing, 1998.

Reference Books

1. J Srinivas, R V Dukkipati and K Ramjee, “Robotics Control and Programming”, Alpha Science International, 1st edition, 2009.
2. S K Saha, “introduction to Robotics “, 2nd edition, TMH, 2013.
3. Stamatios Manesis, George Nikolakopoulos, “Introduction to Industrial Automation”,CRC Press,2018

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	**Module** I	
1.1	Robot classification: Drive technologies, Work-envelope geometries, Motion control methods.	1
1.2	Robot Specification: Number of axes, Capacity and speed, Reach and stroke, Tool orientation, Repeatability, precision and accuracy, operating environment.	3
1.3	Direct Kinematics: Coordinate frames, Rotations, Homogeneous coordinates, Link coordinates, arm equation.	3
2	**Module II**	
2.1	Inverse kinematics: Inverse kinematics problem, General properties of solutions, Tool configuration, Existence and uniqueness of solutions, solutions for 3,4,5 and 6 axes robots.	3
2.2	Workspace analysis and Workspace fixtures, pick and place operation, continuous path motion, interpolated motion, straight line motion.	3
2.3	Differential motion and statics: Manipulator Jacobian, Jacobian inverse, Jacobian singularities, Static analysis.	2
3	**Module III**	
3.1	Manipulator dynamics: Lagrange equation, Kinetic and potential energy, generalized force, Lagrange-Euler dynamic model.	2
3.2	Trajectory planning and generation: Definitions and planning tasks, Joint space techniques, Cartesian space techniques, Joint-Space versus Cartesian Space trajectory planning.	2
3.3	Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control.	3
4	**Module IV**	
4.1	Drives for robots: Hydraulic Drives: Requirements, Hydraulic components in robots; Pneumatic Drives: Components used in pneumatic control;	3
4.2	Electric Drives: Introduction, DC & AC electric motors, stepper motors, Servo motors.	2
4.3	Sensors in Robotics: Position sensors-optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors-Contact, non-contact,	3

	Range Sensing, touch and Slip Sensors, Force and Torque sensors, Temperature, Humidity, Light sensors	
5	**Module V**	
5.1	Robot vision: Vision Sensors, Robot Control through Vision sensors, Robot vision locating position, Robot guidance with vision system.	2
5.2	Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Line balancing,	1
5.3	Automated Materials Handling: Material Handling Equipment, Conveyor Systems, Automated Guided Vehicle Systems, Automated Inspection and Testing: Principles and Methods.	3

CO ASSESSMENT

QUESTIONS

Course Outcome 1 (CO1):

1. How are robot classified based on work envelop geometries?

2 What is meant by repeatablity?

3.What is the transformation matrix for rotation?

Course Outcome 2 (CO2)

1. How is inverse kinematics useful in study of robots?

2.What do you understand by tool configuration?

3. What is meant by manipulator Jacobian?

Course Outcome 3(CO3):

1. State the Lagrangian equation used in analysis of dynamic systems.

2.What is the use of solving the direct and inverse dynamics problems in robot design?

3.Differentiate between point to point and continous control.

Course Outcome 4 (CO4):

1. When do you prefer hydraulic drives to pneumatic drives?

2.What are stepper motors?

3. list different types of temperature sensors.

Course Outcome 5 (CO5):

1. What is meant by robotic vision?

2. What is meant by line balancing?

3. What is meant by automated inspection?

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E105A**

Course Name: Robotics and Automation

Max. Marks:60 Duration: 3 hours

PART A

Part A

(Answer all questions. Each question carries 5 marks)

1. 77What is meant by homogeneous transformation? How is it useful in analysis of robots?
2. Find the inverse kinematics solution of a 2D revolute-revolute robot with arm lenghths 250 mm and 300 mm.
3. Using Lagrangian formulation, determine the dynamic equation of an R-P manipulator in terms of its joint variable and joint torque vectors.
4. Compare the performance of hydraulic and pneumatic drives.
5. Explain the role of computer vision in robotics.

Part B

(Answer any five. Each question carries 7 marks)

6. A point P with coordinates(10,20,0) is translated through a distance of (100, 200,150) units and then rotated through an angle of 60^0 and 90^0 about Y and Z axis. Use homogeneous transformations to find the coordinates of the final position.
7. Find the cubic interpolation polynomial which will smoothly move the robot between the points $w^0=[10,10,10,0.368,0.368,-0.368]^T$ and $w^1=[15,15,15,1,1,-1]^T$ in tool configuration space over the time interval [0,T]. Assume that the velocity is zero at each end of its trajectory.

8. Explain the following with regard to inverse kinematics problems:(1) Existence of solution (2) Uniqueness of solutions.
9. Explain the difference between point to point and continuous control of robots.
10. Explain the different types of electric drives used in robots? What are the criteria used in the selection of these drives?
11. For a 2D two link Revolute-revolute robot, Determine the link Jacobian matrix.
12. Explain the methods used in automation of inspection.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E105B	OPTIMIZATION TECHNIQUES	Elective	3	0	0	3	3

Preamble: This course is designed to facilitate the students to acquire knowledge about the fundamental concepts, theories and methods in optimization. Also, to understand how to take optimal decision using appropriate optimization technique.

Prerequisite : Nil

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

CO no.	Course Outcome Statements	Cognitive Knowledge level
CO 1	To formulate real world problems into mathematical models and to understand one dimensional search methods	Apply
CO 2	To apply the theory of linear programming and integer programming	Apply
CO 3	To understand the constrained optimization using various techniques	Apply
CO 4	To apply multi-objective methodologies in optimization of real-life problems	Understand
CO 5	To develop algorithms for problem using unconventional optimization methods	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1		3	3	1	3
CO 2	1		1	3	2	2
CO 3	1		1	3	3	3
CO 4	1		3	3	3	3
CO 5	1		3	3	3	3

Assessment Pattern

Course name	OPTIMIZATION TECHNIQUES		
Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	20	20	20
Understand	20	20	20
Apply	20	20	20
Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	10

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

Syllabus

Module 1 - Introduction to Optimization & Classical Optimization Techniques

Introduction – Optimization, classification of optimization problems, engineering applications of optimization, concepts of local and global maxima and minima, monotonic and unimodal functions.
Non-linear programming – single variable unconstraint optimization: search and elimination methods - exhaustive search method, Fibonacci method and golden section search; gradient methods – Newton-Raphson method, steepest descent method and bisection method.

(6 hours)

Module 2: Linear Programming & Integer Programming

Linear programming – problem formulation, simplex method, concept of duality, dual simplex method, sensitivity analysis – profit coefficients, capacity of resources, shadow price. Integer Programming – formulation of pure, binary and mixed integer programming problems.

(8 hours)

Module 3: Single/Multi variable constraint Optimization

Mathematical statement, equality and inequality constraints, direct substitution (calculus) method, Lagrange multipliers method – Lagrange algorithm, necessary and sufficient conditions for optimality, problems with equality constraints, handling inequality constraints, Kuhn-Tucker conditions.

(8 hours)

Module 4: Multi-objective Optimization

Multi-objective optimization - generalized mathematical statement, concept of pareto improvement and pareto optimality. Goal programming – problem formulation, the weighted method, Analytic hierarchy process (AHP).

(8 hours)

Module 5: Non-traditional Optimization Techniques

Introduction to evolutionary and swam intelligence algorithms, Genetic Algorithm - working principles, basic GA logic, GA for constrained optimization, other GA operators, Random mixing – mutation, Elitist strategy; Particle swarm optimization – PSO algorithm, implementation of PSO algorithm - psychosocial compromise, inertial weights and acceleration coefficients; Simulated annealing – basic principle, SA analogy, SA algorithm, metropolis criterion.

Text Books

1. Rao, S.S. Optimization: Theory and Applications, Second edition, Wiley eastern, 1994.
2. Gupta, P. K., and Hira, D.S. (2007). Operation Research 6th Edition.S Chand.

Reference Books

1. Simmons, D.M., Ravindran, A., Non-linear Programming for Operations Research, Prentice-Hall, New Jersey, 1975.
2. Ravindran, A., Philips, D.T., and Solberg, J.J., Operations Research: Principles and Practice, Second Edition, John Wiley & Sons, 1987.
3. Reklatis, G.V., Ravindran, A., and Ragsdell, K.M., Engineering Optimization: Methods and applications, Wiley Interscience, New York, 1983.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lectures
1	**Introduction to Optimization & Classical Optimization Techniques (6 Hours)**	
1.1	Introduction – Optimization, classification of optimization problems, engineering applications of optimization, concepts of local and global maxima and minima, monotonic and unimodal functions.	2
1.2	Non-linear programming – single variable unconstraint optimization: search and elimination methods - exhaustive search method, Fibonacci method and golden section search.	2
1.3	Gradient methods – Newton-Raphson method, steepest descent method and bisection method.	2
2	**Linear Programming & Integer Programming (8 Hours)**	
2.1	Linear programming – problem formulation, simplex method, concept of duality, dual simplex method.	4
2.2	Sensitivity analysis – profit coefficients, capacity of resources, shadow price.	2
2.3	Integer Programming – formulation of pure, binary and mixed integer programming problems.	2
3	**Single/Multi variable constraint Optimization (8 Hours)**	
3.1	Mathematical statement, equality and inequality constraints, direct substitution (calculus) method.	2
3.2	Lagrange multipliers method – Lagrange algorithm, necessary and sufficient conditions for optimality.	3
3.3	Problems with equality constraints, handling inequality constraints, Kuhn-Tucker conditions.	3
4	**Multi-objective Optimization (8 Hours)**	
4.1	Multi-objective optimization - generalized mathematical statement, concept of pareto improvement and pareto optimality.	3
4.2	Goal programming – problem formulation, the weighted method.	3
4.3	Analytic hierarchy process.	2
5	**Non-traditional Optimization Techniques (10 Hours)**	
5.1	Introduction to evolutionary and swam intelligence algorithms, Genetic Algorithm - working principles, basic GA logic, GA for constrained optimization, other GA operators, Random mixing – mutation, Elitist strategy.	4
5.2	Particle swarm optimization – PSO algorithm, implementation of PSO algorithm - psychosocial compromise, inertial weights and acceleration coefficients.	3
5.3	Simulated annealing – basic principle, SA analogy, SA algorithm, metropolis criterion.	3
	Total	**40**

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E105B**

Course Name: **OPTIMIZATION TECHNIQUES**

Max. Marks:60 Duration: 3 hours

Part A

(Answer all questions. Each question carries 5 marks)

1. Write the concept of optimization with a suitable example.
2. Distinguish between Primal and Dual in Linear Programming problem.
3. Explain the direct substitution (calculus) method in Multi variable constraint optimization.
4. Explain the concept of Goal Programming in multi – objective optimization with suitable example.
5. Give the generic concept of Simulated Annealing with suitable example.

Part B

(Answer any five. Each question carries 7 marks)

6. Find r to minimize $A = 2\pi r^2 + 2\pi rh$ subject to $\pi r^2 h = 6$. Take the initial interval of uncertainty as 0.5 m – 4.5 m and step size = 0.5 m using Exhaustive Search Method.
7. Find the minimum of $z = 4x_1 + 6x_2$

   Subject to constraints;

   $x_1 + x_2 \geq 8$

   $6x_1 + x_2 \geq 12$

$x_1, x_2 \geq 0$

8. Find the maximum of $f(x) = - x_1^2 - x_2^2 + 4x_1 + 4x_2 - 8$

   Subject to constraints;

   $X_1 + 2x_2 \leq 4$

   $2x_1 + x_2 \leq 5$, using Kuhn – Tucker conditions.

9. Two products; A and B are assembled in an industry. Product A requires 4 hours for assembly whereas B requires 3 hours. The regular time available for assembly is 90 hours. The profit per unit of A and B are Rs.7 and Rs.8 respectively. Overtime is available but reduces the profit by Rs.1. The demand for product A and B are 30 and 40 units respectively. The goals are (i) target to be met: regular time is 90 hours (ii) Minimize OT (iii) Maximize profit. Formulate problem for goal programming.

10. Maximize the objective function $f(x) = 1 + 2x - x^2$

    Assume the following control parameters:

    $W = 0.7$, $c_1 = 0.20$, $c_2 = 0.60$

    n = 5 (number of swarm particle)

    E = number of iteration = 2, using Particle Swarm Optimization.

11. Find the minimum of the following function using simulated annealing

    Minimize $f(x) = 500 - 20x_1 - 26x_2 - 4x_1x_2$

    Initial interval of uncertainty:

    $-2 < x1 < 10$

    $-1 < x2 < 11$

    Assume:

    Temperature reduction factor c = 0.8

    Number of iterations n = 2

12. The cost of engines and fuel for a cargo ship (in lakh of rupees per year for 100 tons of cargo carried) varies with speed of the ship and is given by 0.2x2, where x is the speed of the ship in m/s. The fixed cost of hull and crew is given by 450/x. using GA, determine the optimal operating speed of the ship. The original interval of uncertainty can be taken as $0.5 \leq x \leq 25.5$ m/s. (Limit No. of iteration = 2).

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E105C	FLEXIBLE MANUFACTURING SYSTEMS	Elective	3	0	0	3	3

Preamble : This course helps the students to understand the concept of flexible manufacturing systems, their components and operational decisions required for controlling such systems. The course also covers quantitative analysis that may be used with regard to FMS and fundamental concepts and programming of a Programmable Logic Controller (PLC).

Prerequisite : nil

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

CO no.	Course Outcome Statements	Cognitive knowledge level
CO 1	Perform modeling, design and simulation of flexible manufacturing systems	Apply
CO 2	Gain insight about the research areas related to FMS and real-time shop floor control	Apply
CO 3	Develop an understanding on flexible manufacturing systems	Apply
CO 4	Develop an understanding on Automated Material Handling and Storage	Understand
CO 5	To create basic PLC programmings in flexible manufacturing systems	Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1	1	3	3	3	2
CO 2	3	3	2			2
CO 3	2	2	2			
CO 4	2	2	2			
CO 5	1	1	3	3	3	2

Assessment Pattern

Course name	FLEXIBLE MANUFACTURING SYSTEMS		
Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	20	20	20
Understand	20	20	20
Apply	20	20	20

Analyse	20	20	20
Evaluate	10	10	10
Create	10	10	10

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (6 hours)

Introduction to FMS: Definition of FMS, Types and configuration concepts, Types of flexibility, Functions of FMS host computer, FMS host and area controller function distribution.
Database in FMS: Manufacturing data systems and data flow, CAD and CAM considerations for FMS, database systems.

MODULE 2 (8 hours)

Development and implementation of FMS: Planning phases, Integration, System configuration, FMS layouts, Simulation, FMS project development steps and management, Equipment

development, Host system development, Hardware and software development.
Planning and scheduling of FMS: Quantitative Analysis of FMS, Bottleneck Model , Terminology and symbols, FMS Operational Parameters, System performance measures, Extended Bottleneck model, Sizing the FMS, Problems.

MODULE 3 (6 hours)
Pioneering integrated systems: Different flexible systems- Molins,
Chalmers etc, Different pallets and fixtures for prismatic and turned parts, Prismatic parts machines.
Distributed numerical control: DNC system, Communication between DNC computer and machine control unit, Hierarchical processing of data in DNC system, Features of DNC system specific to FMS.

MODULE 4 (8 hours)

Automated material handling: Functions, Types, Quantitative analysis of material handling equipment, Design of conveyors and AGV systems.
Automated storage: Storage system performance, AS/RS, Carousel storage system, Quantitative Analysis, WIP storage, Interfacing handling and storage with manufacturing..

MODULE 5 (8 hours)
Programmable logic controllers in FMS: Role of PLCs in Manufacturing
and Assembly operations in a CIM environment, PLC Input instructions and Outputs, PLC Timer and Counter functions, Creating relay logic diagrams and screen patterns for various operations in FMS from their process control descriptions.
Design of automated assembly systems, FMS case studies in aerospace
machining, Sheet metal fabrication applications, Toyota production system, The Rover LM-500 FMS – The HNH (Hattersley Mewman Hender) FMS etc.

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Text Books

1. Parrish D. J., "Flexible manufacturing", Butterworth – Heinemann Ltd, 1990
2. Groover M. P., "Automation, production systems and computer integrated manufacturing", Prentice Hall India (P) Ltd., 2002.

Reference Books

1. . Shivanand H. K., Benal M. M and Koti V, "Flexible manufacturing system", New Age International (P) Limited. Publishers, 2006
2. . Kusiak A., "Intelligent manufacturing systems", Prentice Hall, Englewood Cliffs, NJ, 1990
3. Joseph Talavage and Roger G. Hannan, Flexible Manufacturing Systems in practice, Marcel Dekker, Inc. New York, 1988.

4. Considine D. M. & Considine G. D., "Standard handbook of industrial automation", Chapman and Hall, London, 1986
5. Viswanadhan N. and Narahari Y., "Performance modeling of automated manufacturing Systems", Prentice Hall India (P) Ltd., 1992
6. John W. Webb and Ronald A. Reis "Programmable Logic Controllers", Prentice Hall India. (P) Ltd., 2006
7. Ranky P. G., "The design and operation of FMS", IFS Pub, U. K, 1998

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. Of Lectures
1	**Module 1: Introduction and database of FMS**	**6 hrs**
1.1	Introduction to FMS: Definition of FMS, Types and configuration concepts, Types of flexibility, Functions of FMS host computer, FMS host and area controller function distribution.	4 hrs
1.2	Database in FMS: Manufacturing data systems and data flow, CAD and CAM considerations for FMS, database systems.	2 hrs
2	**Module 2: Development, implementation, planning and scheduling of FMS**	**8 hrs**
2.1	Development and implementation of FMS: Planning phases, Integration, System configuration, FMS layouts, Simulation, FMS project development steps and management, Equipment development, Host system development, Hardware and software development.	4 hrs
2.2	Planning and scheduling of FMS: Quantitative Analysis of FMS, Bottleneck Model , Terminology and symbols, FMS Operational Parameters, System performance measures, Extended Bottleneck model, Sizing the FMS, Problems.	4 hrs
3	**Module 3: Pioneering Integrated System and DNC System**	**6 hrs**
3.1	Pioneering integrated systems: Different flexible systems- Molins,	3 hrs

	Chalmers etc, Different pallets and fixtures for prismatic and turned parts, Prismatic parts machines.	
3.2	Distributed numerical control: DNC system, Communication between DNC computer and machine control unit, Hierarchical processing of data in DNC system, Features of DNC system specific to FMS.	3 hrs
4	**Module 4: Automated Material Handling and Storage**	**8 hrs**
4.1	Automated material handling: Functions, Types, Quantitative analysis of material handling equipment, Design of conveyors and AGV systems.	4hrs
4.2	Automated storage: Storage system performance, AS/RS, Carousel storage system, Quantitative Analysis, WIP storage, Interfacing handling and storage with manufacturing.	4 hrs
5	**Module 5: PLC and Design of automated assembly systems**	**8 hrs**
5.1	Programmable logic controllers in FMS: Role of PLCs in Manufacturing and Assembly operations in a CIM environment, PLC Input instructions and Outputs, PLC Timer and Counter functions, Creating relay logic diagrams and screen patterns for various operations in FMS from their process control descriptions.	4 hrs
5.2	Design of automated assembly systems, FMS case studies in aerospace machining, Sheet metal fabrication applications, Toyota production system, The Rover LM-500 FMS – The HNH (Hattersley Mewman Hender) FMS etc.	4 hrs

CO ASSESSMENT QUESTIONS Course

Outcome 1 (CO1):

1. Design a conveyor system for FMS.

2. Explain quantitative analysis of material handling equipment with an example.

3. Explain about AS/RS in detail..

Course Outcome 2 (CO2)

1. Explain Rover LM- 500 FMS in detail.

2. Explain recent FMS trends in sheet metal fabrication applications.

3. Explain the latest database system in FMS.

Course Outcome 3 (CO3):

1. Explain about functions of the FMS host computer.
2. Explain quantitative analysis of material handling equipment with an example.
3. Explain about planning phases in FMS.

Course Outcome 4 (CO4):

1. Differentiate between counters and timers.
2. Explain about PLC Input instructions and Outputs.
3. Create a relay logic diagram for automated material handling in FMS

Model Question Paper

QP CODE: Pages: X

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E105C**

Course Name: **FLEXIBLE MANUFACTURING SYSTEMS**

Max. Marks:60 Duration: 3 hours

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain about different types of flexibility in detail.
2. Explain about different types of layouts in FMS.
3. Briefly explain about different pallets and fixtures for prismatic parts.
4. Briefly explain about different types of AGVs.
5. Discuss about PLC timer functions.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Discuss about CAD/CAM considerations for FMS.
7. Explain FMS operational parameters and system performance measures in the Bottleneck model.
8. Explain in detail about the DNC computer and machine control unit.
9. Following are the data of AGV system:

   Vehicle Velocity = 45 m/min.
   Average distance traveled/delivery = 135m
   Pick up time = 45 sec.
   Drop off time = 45 sec.
   Average distance traveling empty = 90 m
   Traffic factor = 0.9

Determine the number of vehicles required to satisfy the delivery demand if the delivery demand is 40 deliveries per hour. Also determine the handling system efficiency.

10. Explain about different types of automated assembly systems with a neat diagram.
11. Discuss about different types of buses used in PLC.
12. Explain about FMS planning phases in detail.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME2R106	RESEARCH METHODOLOGY & IPR	Theory	2	0	0	2	2

Preamble: This course introduces the strategies and methods related to scientific research. It covers salient aspects of publication and patenting along with the crucial role of ethics in research. This course will equip students to define research problem and to adopt suitable methodologies for the solution of problem. The students are trained in the oral presentation with visual aids and writing technical thesis/reports/research papers.

Prerequisite: NIL

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

CO No.	CO Statement	Cognitive Knowledge Level
CO 1	Approach research projects with enthusiasm and creativity.	Apply
CO 2	Conduct literature survey and define research problem.	Apply
CO 3	Adopt suitable methodologies for solution of the problem.	Analyze
CO 4	Deliver well-structured technical presentations and write technical reports.	Apply
CO 5	Publish/Patent research outcome.	Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	3	1		1	3
CO 2	2	3	1		1	3
CO 3	2	3	1		1	3
CO 4	2	3	1		1	3
CO 5	2	3	1		1	3

Assessment Pattern

Course name	Research Methodology & IPR		
Bloom's Category	Continuous Assessment Tests		End Semester Examination (%Marks)
	Test 1 (% Marks)	Test 2 (% Marks)	
Remember	XX	XX	XX

Understand	20	20	20
Apply	60	60	60
Analyse	20	20	20
Evaluate	XX	XX	XX
Create	XX	XX	XX

Mark Distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications in the relevant discipline (minimum 10 publications shall be referred) : 10 marks

Course based task/Seminar/Quiz : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

End Semester Examination Pattern: The end semester examination should be conducted by the college. The time duration will be for 3 hrs and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

SYLLABUS

MODULE 1 (5 Hours)

Meaning, and objective of research, Motivation for research

Types of research, Research Approaches, significance of research, Characteristics of good research, Research process.

Thinking skills: Types and Levels of thinking - common-sense, scientific thinking, and logical thinking.

Creativity: Some definitions, illustrations from day-to-day life, intelligence versus creativity, creative process, requirements for creativity.

MODULE 2 (4 Hours)

Literature survey and Problem definition

Information gathering – reading, searching and documentation, Types of literature.

Integration of research literature and identification of research gaps, Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem, Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples.

MODULE 3 (6 Hours)

Experimental and modelling skills

Scientific method, role of hypothesis in experiment, dependent and independent variables, control in experiment, precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors.

Design of experiments, experimental logic and documentation.

Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills.

Continuum/meso/micro scale approaches for numerical simulation, Case studies illustrating experimental and modelling skills.

MODULE 4 (5 Hours)

Effective communication - oral and written

Examples illustrating the importance of effective communication, stages and dimensions of a communication process.

Oral communication –verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc.

Guidelines for preparation of good presentation slides.

Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX.

Common errors in typing and documentation.

MODULE 5 (5 Hours)

Publication and Patents

Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper.

Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics.

Introduction to IPR, Concepts of IPR, Types of IPR, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark.

Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures.

References

1. Panneerselvam, “Research Methodology”, Prentice Hall of India, New Delhi, 2012.
2. C. R. Kothari, “Research Methodology”, New Age International, 2004
3. E. M. Phillips and D. S. Pugh, "How to get a PhD - a handbook for PhD students and their supervisors", Viva books Pvt Ltd.

4. G. L. Squires, "Practical physics", Cambridge University Press
5. Antony Wilson, Jane Gregory, Steve Miller, Shirley Earl, “Handbook of Science Communication”, Overseas Press India Pvt Ltd, New Delhi, 1st edition 2005
6. Leedy P. D., “Practical Research: Planning and Design”, McMillan Publishing Co.
7. Day R. A., “How to Write and Publish a Scientific Paper”, Cambridge University Press, 1989.
8. William Strunk Jr., “Elements of Style”, Fingerprint Publishing, 2020
9. Peter Medawar, “Advice to Young Scientist”, Alfred P. Sloan Foundation Series, 1979.
10. E. O. Wilson, “Letters to a Young Scientist”, Liveright, 2014.
11. R. Hamming, “You and Your Research”, 1986 Talk at Bell Labs.

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1 (5 Hours)	
1.1	Meaning, and objective of research, Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming.	1
1.2	Types of research, Research Approaches.	1
1.3	Significance of research, Characteristics of good research, Research process.	1
1.4	Thinking skills: Types and Levels of thinking - common-sense, scientific thinking, and logical thinking.	1
1.5	Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity.	1
	Module 2 (4 Hours)	
2.1	Information gathering – reading, searching and documentation, types of literature	1
2.2	Integration of research literature and identification of research gaps	1
2.3	Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem	1

2.4	Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples	1
Module 3 (6 Hours)		
3.1	Scientific method, role of hypothesis in experiment, dependent and independent variables, control in experiment	1
3.2	Precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, statistical treatment of data, definition, detection and elimination of systematic errors	1
3.3	Design of experiments, experimental logic and documentation	1
3.4	Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills	1
3.5	Continuum/meso/micro scale approaches for numerical simulation, Case studies illustrating experimental and modelling skills.	2
Module 4 (5 Hours)		
4.1	Examples illustrating the importance of effective communication, stages and dimensions of a communication process	1
4.2	Oral communication –verbal and non-verbal, casual, formal and informal communication, interactive communication, listening, form, content and delivery, various contexts for speaking- conference, seminar etc.	1
4.3	Guidelines for preparation of good presentation slides.	1
4.4	Written communication – Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc. Tools for document preparation-LaTeX.	1
4.5	Common errors in typing and documentation	1
Module 5 (5 Hours)		
5.1	Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper.	1

5.2	Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics	1
5.3	Introduction to IPR, Concepts of IPR, Types of IPR	1
5.4	Common rules of IPR practices, Types and Features of IPR Agreement, Trademark	1
5.5	Patents- Concept, Objectives and benefits, features, Patent process – steps and procedures	1

Model Question Paper

Pages: 1

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME2R106**

Course Name: **RESEARCH METHODOLOGY & IPR**

Max. Marks:60 Duration: 3 hours

Answer any five questions. Each question carries 12 marks.

1. (a) Discuss the salient recommendations for great research recommended by Richard Hamming in his famous talk "You and Your Research". (4 marks)

   (b) Classify different types of researches. (8 marks)

2. (a) List out the different steps for identification of research gaps. (6 marks)

   (b) Classify various types of literature. (6 marks)

3. (a) Distinguish between continuum, meso-scale and micro scale approaches for numerical simulation. (6 marks)

   (b) Illustrate the role of approximations in research. (6 marks)

4. (a) Discuss any four rules of scientific writing. (4 marks)

   (b) List out the Guidelines for preparation of good presentation slides. (8 marks)

5. (a) Examine the requirements for patentability? (6 marks)

   (b) Contrast between copyright and trademark protection. (6 marks)

6. (a) What are the characteristics of a good research question? Discuss with an example. (6 marks)

   (b) Explain the various sources of research problem. (6 marks)

7. (a)Discuss the various stages and dimensions of communication process. (6 marks)

8. (b) Compare Journal level, Article level and Author level research metrics. (6 marks)

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1L107	PRODUCTION ENGINEERING LAB	Laboratory	0	0	3	2	2

Preamble :

- To introduce students to the basics of modern Machining concepts
- To make students familiarize with different manufacturing processes.
- To convey the knowledge about the Microstructure of different materials
- To introduce the testing procedure for determining the mechanical properties
- To introduce 3D modeling and 3D printing

Prerequisite:Nil

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

CO No.	CO Statements	Cognitive level Knowledge
CO 1	To acquaint with machine tools like copying lathe, Capstan lathe, surface grinding machine and cylindrical grinding machine	Apply
CO 2	To acquire knowledge on various advanced welding process.	Apply
CO 3	To gather knowledge regarding NC, CNC machines and 3D printing and measurement of process parameters	Apply
CO4	To study metallurgical properties of welded joints.	Understand
CO 5	To acquire knowledge on composite material and testing of mechanical properties	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	-	-	-	1
CO 2	2	2	-	2	-	1
CO 3	2	2	-	-	3	1
CO 4	2	2	-	-	-	1
CO 5	2	2	-	2	-	1
	2	2	-	2	-	1

Mark distribution

Total Marks	CIA Marks

100	100

Continuous Internal Evaluation Pattern:

Lab work and Viva-voce : 60 marks
Final assessment Test and Viva voce : 40 marks

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

SYLLABUS

LIST OF EXPERIMENTS

SL.NO		COURSE OUTCOMES	HOURS
1	Exercise on Copying lathe	CO1, CO2	2
2	Exercise on CNC machine	CO1, CO3	2
3	Exercise on cylindrical / surface grinding and tool grinding machines	CO1	2
4	Experiments on TIG welding, to find out the mechanical properties of metals	CO4, CO3	2
5	Experiments on MIG welding, to find out the mechanical properties of metals	CO2, CO5	2
6	Non-destructive tests on welded joints	CO4, CO5	2
7	Evaluations of tool face temperature using thermocouple		2
8	Roughness of machined surface- Influence of tool geometry and feed rate	CO3	2
9	Determination of cutting forces in turning using tool dynamometer	CO3	2
10	Exercise on 3D printing	CO3	6
11	Chip formation in machining processes under different process parameters	CO3	2
12	Fabrication and testing of Fiber Reinforced Polymer Composite	CO5	6
13	Micro Hardness testing of ceramics	CO4, CO5	2
14	Study of the Micro Structure of pure metals like Iron, Copper and Aluminum.	CO5	2

Semester 2

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1T201	**ADVANCED METAL FORMING**	Core	3	0	0	4	43

Preamble:

This course focuses on the key topics of metal forming. It covers topics such as flow curves & Yield criteria. Also, modelling of metal forming processes is included in this course like Slab analysis, Upper and lower bound techniques, Slip line field theory, soft computing techniques, and Numerical methods. This syllabus also features a Review of metal forming processes: Forging, Rolling, Drawing and Extrusion. The Forces and geometrical relationship in these processes and analyses are included. A review of various sheet forming methods is also incorporated in this course..

Prerequisite: Nil

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

CO no.	Course Outcome Statements	Cognitive knowledge level
CO 1	To use the concepts of flow curve, yield criteria and two-dimensional plastic flow	Apply
CO 2	To explain the mechanics of metalworking	Apply
CO 3	To investigate the modelling of metal forming processes	Apply
CO 4	To design a forging die and to analyse the forging and rolling loads	Apply
CO 5	To analyse the extrusion, wire drawing, tube drawing and sheet metal formability.	Analyse

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		2	3		
CO 2	3		3	3		
CO 3	3		3	3		
CO 4	3		3	3	1	
CO 5	3		3	3	1	

Assessment Pattern

Bloom's Category	ADVANCED METAL FORMING		
	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	0	0	0
Understand	0	0	0
Apply	0	0	0
Analyse	52	52	52
Evaluate	30	30	30
Create	18	18	18

Mark distribution

Total Marks	CIA marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hr.

SYLLABUS

MODULE 1 (7 hours)

Introduction to the theory of plasticity: State of stress − Principal stress and Mohr's circle representation in 3 dimensions – Constitutive equations − Flow curve – Yield criteria − Von Mises, Tresca yield criteria – Relationship between tensile and shear yield stresses – Two-dimensional plastic flow.

MODULE 2 (7 hours)

Fundamentals of metal forming: Classification of forming processes - Mechanics of metal working - Flow stress determination - Effect of temperature, Strain rate and metallurgical factors in metalworking - Friction and lubrication - Residual stresses

MODULE 3 (8 hours)

Modelling of metal forming processes - Slab analysis - Plane strain compression of solid billet, Axially symmetric compression of solid billet - Upper and lower bound techniques - Plane strain extrusion- Slip line field theory - Soft computing techniques -Numerical methods for working load estimation.

MODULE 4 **(9 hours)**

Forging: Review on forging process – Forging die design - Forging in plane strain - Calculation of forging loads - Forging defects - Causes and remedies - Residual stresses in forging. Rolling: Review of rolling processes - Forces and geometrical relationship in rolling - Analysis of rolling load - Torque and power - Rolling mill control - Rolling defects..

MODULE 5 (9 hours)

Extrusion: Review of extrusion and drawing processes – Analysis of extrusion – drawing of rods, wires, and tubes- Analysis of wire drawing and tube drawing. Sheet metal forming: Review of various sheet forming methods -Sheet metal formability - Formability limit criteria - Defects in formed parts

Text Books

1. Hosford, William F., and Robert M. Caddell. Metal forming: mechanics and metallurgy. Cambridge university press, 2011.
2. Dieter, George Ellwood, and David Bacon. Mechanical metallurgy. Vol. 3. New York: McGraw-hill, 1976.

Reference Books

1. Dixit, Uday S., and R. Ganesh Narayanan. Metal forming: technology and process modelling. McGraw-Hill Education, 2013.

2. Avitzur, Betzalel. "Metal Forming. Processes And Analysis." Mcgraw-Hill, Inc., New York. 1968.
3. Rowe, G. W. "An introduction to the principles of metalworking'; 1965." London, Edward Arnold. Lange, Kurt. "Handbook of metal forming." McGraw-Hill Book Company, 1985..

COURSE CONTENTS AND LECTURE SCHEDULE

COURSE PLAN		
MODULES	**Contact hours**	**Sem. Exam Marks; (%)**
Module 1 Introduction to the theory of plasticity: State of stress − Principal stress and Mohr's circle representation in 3 dimensions – Constitutive equations − Flow curve – Yield criteria − Von Mises, Tresca yield criteria – Relationship between tensile and shear yield stresses – Two-dimensional plastic flow.	7	12 (20)
Module 2 Fundamentals of metal forming: Classification of forming processes - Mechanics of metal working - Flow stress determination - Effect of temperature, Strain rate and metallurgical factors in metalworking - Friction and lubrication - Residual stresses	7	12 (20)
FIRST INTERNAL TEST		
Module 3 Modelling of metal forming processes - Slab analysis - Plane strain compression of solid billet, Axially symmetric compression of solid billet - Upper and lower bound techniques - Plane strain extrusion- Slip line field theory - Soft computing techniques -Numerical methods for working load estimation.	8	12 (20)
Module 4 Forging: Review on forging process – Forging die design - Forging in plane strain - Calculation of forging loads - Forging defects - Causes and remedies - Residual stresses in forging. Rolling: Review of rolling processes - Forces and geometrical	9	12 (20)

relationship in rolling - Analysis of rolling load - Torque and power - Rolling mill control - Rolling defects.		
SECOND INTERNAL TEST		
Module 5 Extrusion: Review of extrusion and drawing processes – Analysis of extrusion – drawing of rods, wires, and tubes- Analysis of wire drawing and tube drawing. Sheet metal forming: Review of various sheet forming methods - Sheet metal formability - Formability limit criteria - Defects in formed parts	9	12 (20)

Course Plan

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Introduction to the theory of plasticity: State of stress − Principal stress and Mohr's circle representation in 3 dimensions	2
1.2	Constitutive equations − Flow curve	1
1.3	Yield criteria − Von Mises, Tresca yield criteria - Relationship between tensile and shear yield stresses	2
1.4	Two-dimensional plastic flow.	2
2	**Module 2**	
2.1	Fundamentals of metal forming: Classification of forming processes	1
2.2	Mechanics of metal working - Flow stress determination	2
2.3	Effect of temperature, Strain rate and metallurgical factors in metalworking	2
2.4	Friction and lubrication - Residual stresses	2
3	**Module 3**	
3.1	Modelling of metal forming processes - Slab analysis - Plane strain compression of solid billet, Axially symmetric compression of solid billet	2

3.2	Upper and lower bound techniques - Plane strain extrusion	2
3.3	Slip line field theory	2
3.4	Soft computing techniques -Numerical methods for working load estimation.	2
4	**Module 4**	
4.1	Forging: Review on forging process – Forging die design	1
4.2	Forging in plane strain - Calculation of forging loads	2
4.3	Forging defects - Causes and remedies - Residual stresses in forging	1
4.4	Rolling: Review on rolling processes - Forces and geometrical relationship in rolling	1
4.5	Analysis of rolling load - Torque and power	2
4.6	Rolling mill control - Rolling defects.	2
5	**Module 5**	
5.1	Extrusion: Review on extrusion and drawing processes – Analysis of extrusion	2
5.2	drawing of rods, wires, and tubes- Analysis of wire drawing and tube drawing.	2
5.3	Sheet metal forming: Review on various sheet forming methods -	2
5.4	Sheet metal formability - Formability limit criteria -	2
5.5	Defects in formed parts	1

Model Question Paper

QP CODE: Pages: X

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MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1T201**

Course Name: **ADVANCED METAL FORMING**

Max. Marks:60 Duration: 3 hours

Part A

(Answer all questions. Each question carries 5 marks).

1. a) If the principal stresses on a material with yield stress in shear of 210 MPa are σ_2 = 180 MPa and σ_1 = 360 MPa., what is the stress, σ_3, at yielding according to the Tresca criterion?
   b) If the stresses in (a) were compressive, what tensile stress σ_3 must be applied to cause yielding according to the Tresca criterion?
2. Compare the temperature rise when a cylinder of aluminium and titanium is quickly deformed to $\underline{\epsilon}$ = 1.0 at room temperature.

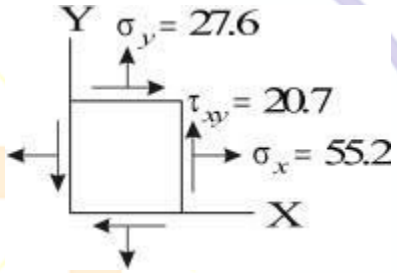
	$\underline{\sigma}$, MPa	$\underline{\epsilon}$	ρ, kgm^{-3}	c, Jkg^{-1}K^{-1}
Al	225	1	2690	900
Ti	420	1	4500	519

3. A 2.75 mm thick metal sheet 30 cm wide is drawn to a thickness of 2.25 mm through a die of the included angle of 25°. The flow stress is 210 MPa and the friction coefficient is 0.075. Calculate the drawing force using the von Mises criterion.
4. Calculate the rolling load if the steel sheet is hot rolled 25 per cent from a 35 mm-thick slab using a 900 mm-diameter roll. The slab is 780 mm wide. Assume μ = 0.25. The plane-strain flow stress is 150 MPa at the entrance and 210 MPa at the exit from the roll gap due to the increased velocity.
5. Determine the drawing stress to produce a 25-per cent reduction in a 15-mm stainless steel wire. The flow stress is given by $\sigma_0 = 1250\varepsilon^{0.30}$ (MPa). The die angle is 14° and μ = 0.09

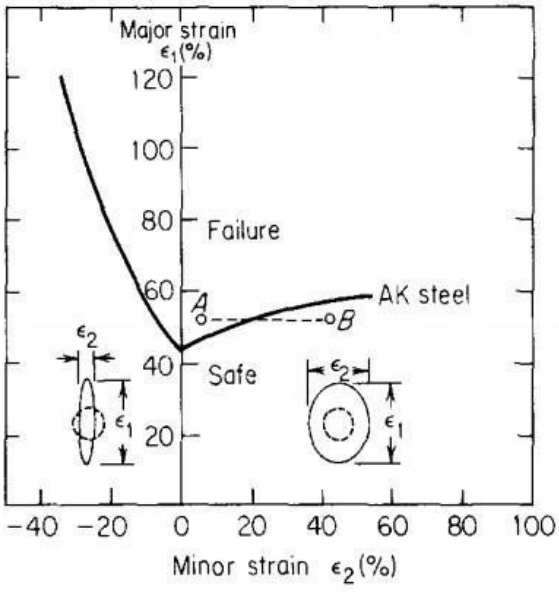
Part B

(Answer Any five questions. Each question carries 7 marks)

1. At a point in the structural member, the stresses (in MPa) are represented as in fig. Employ Mohr's circle to determine:
   a. the magnitude and orientation of the principal stresses
   b. The magnitude and orientation of the maximum shearing stress and associated normal stresses.



2. Explain Friction hill, Sticking friction and Interface friction factor.
3. Explain the construction of a Hodograph.
4. A block of lead 30 mm x 25 mm x 150 mm is pressed between flat dies to a size 6.5 mm x 110 mm x 150 mm. If the uniaxial flow stress is σ_0 = 8 MPa and μ = 0.3 determine the pressure distribution over the 110 mm dimension and the total forging load.
5. An aluminium alloy is hot extruded at 425°C at 60 mm s^{-1} from 160 mm diameter to 60 mm diameter. The flow stress at this temperature is given by $\underline{\sigma} = 210 * \dot{\epsilon}^{0.15}$ (MPa). If the billet is 390 mm long and the extrusion is done through square dies without lubrication, determine the force required for the operation.
6. Explain a) Erichsen test b) Forming Limit Diagram.
7. A grid of 2.6 mm circles is electro etched on a blank of sheet steel. After forming into a complex shape the circle in the region of critical strain is distorted into an ellipse with a major diameter of 4.75 mm and a minor diameter of 2.3 mm. How close is the part to failing in this critical region? The keeler-Goodwin forming limit diagram is given.



SYLLABUS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
M24ME1E202	INDUSTRIAL TRIBOLOGY	Theory	3	0	0	3

Preamble: This course delves into the essential principles and practices of industrial tribology, focusing on the study of friction, wear, and lubrication in engineering systems. Students will explore the fundamental concepts that govern the interactions between surfaces in relative motion and how these interactions impact the performance and longevity of mechanical systems.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO	CO Statement	Cognitive Knowledge Level
CO 1	Understand the principles of friction, wear and lubrication	Understand
CO 2	Select the methods used to combat friction and wear related issues.	Apply
CO 3	Identify, analyse and address industrial friction and wear related problems	Apply
CO 4	Select the of hydrodynamic, hydrostatic and antifriction bearings based on the design criteria.	Analyse

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	x	x	x				
CO 2	x				x		x
CO 3	x			x	x	x	x
CO 4	x			x	x	x	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	
Analyse	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration

100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

End Semester Examination Pattern:

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the various stages of wear and the mechanisms of wear.

2. What are the different surface roughness measuring methods?

3. Explain the different theories of friction.

Course Outcome 2 (CO2)

1. Explain squeeze film lubrication.

2. Describe the mechanism of hydrodynamic oil film formation

3. Derive the load carrying capacity of a hydrostatic thrust bearing

Course Outcome 3(CO3):

1. Discuss the wear testing methods in Tribology

2. Write a short note on classification of bearings.

3. Discuss the role of restrictors in the design of hydrostatic bearings.

Course Outcome 4 (CO4):

1. Design a self-aligning ball bearing for a radial load of 7000 N and a thrust load of 2100 N. The desired life of the bearing is 160 million of revolution at 300 r.p.m. Assume uniform and steady load.

2. In a journal bearing. diameter of the shaft is 75mm, *L/D=1,* radial clearance is 0.05 mm, h_0=0.02mm, speed of journal=400rpm, radial load- 3.5kN, specific gravity of oil = 0.9 and specific heat of oi1=1.75kj/kg/^oC. Calculate the viscosity of a suitable oil, power lost in friction and the resultant temperature rise.

3. A circular hydrostatic pad has a constant flow rate Q. The circular pad is supporting a load of W = 5000N. The outside disk diameter is 200 mm and the diameter of the circular recess is 100 mm. The oil viscosity is μ = 0.005 Ns/M2. The pad is operating with a clearance of 120 μm.
a. Find the recess pressure, Pr
b. Calculate the constant flow rate of the oil through the bearing to maintain the clearance.

c. Find the effective area of this pad.
d. Find the stiffness of the circular pad operating under the condition in this problem.

Syllabus and Course Plan (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

No	Topic	No. of Lectures
1	Module 1	
1.1	Introduction to tribology	2
1.2	Analysis of surface roughness- Measurement of surface roughness- Measurement of real area of contact	
1.3	Friction: Types of friction-dry-boundary and fluid-laws of friction and friction theories-Tomlinson hypothesis, Bowden and Tabor theory	3
1.4	Friction of metals, ceramic materials and polymers-Variables in friction– Surface cleanliness – effect of pressure, velocity, temperature, vibration etc.	3
2	Module 2	
2.1	Wear – Classification – Running in wear-theories of wear- stages of wear	2
2.2	Types of wear mechanisms- adhesive and abrasive wear- factors affecting wear. Types of particles present in wear debris	3
2.3	Wear of materials. Tests and Instrumentation in Tribology. Sliding friction and wear abrasion test, rolling contact and fatigue test, solid particle and erosion test, Corrosion test	3
3	Module 3	
3.1	Lubrication: Role of lubrication- Lubricants-selection of lubricants	2
3.2	Importance of viscosity and methods for measuring viscosity	3
3.3	Fundamentals of viscous flow- flow through capillary tube – flow between parallel plates -radial flow between parallel circular plates - Squeeze film lubrication	3
4	Module 4	
4.1	Bearings - classification and applications	1
4.2	Hydrodynamic bearings: Journal bearings eccentricity-pressure distribution – attitude angle, load carrying capacity	2
4.3	friction and power loss-ideal and real bearings – leakage factors – sommerfield number and design charts	3
4.4	Oil flow and heat dissipation in bearings- Analysis of hydro thrust bearings	2
5	Module 5	
5.1	Hydrostatic bearings: Analysis of oil pads-hydrostatic step bearings hydrostatic thrust bearing with shoes	2
5.2	Rolling element bearings, Types - static and dynamic capacities	3
5.3	Bearing life, cyclic loading, Selection of bearings	3

Reference Books

1. Fuller D.D: Theory and practice of lubrication for Engineers – John Willey& Sons, Inc.

2. Bharat Bhusan: Introduction to Tribology- John Wiley & Sons, Inc

3. Khonsari and Booser: Applied Tribology: Bearing Design and Lubrication, Wiley

4. BC Majumdar: Introduction to Tribology of Bearing, S Chand Publishing

5. Principles of Lubrication – A Cameron, Longman's Green Co. Ltd

6. Radzimovsky: Theory of lubrication of bearings, The Donald Press Company, London

7. Sushilkumar Srivastva: Tribology in Industries, S Chand Publishing

8. A. D. Sarkar: Friction and Wear, Pergamon

9. O'Conner and Boyd : Standard Hand Book of Lubrication Engineering McGraw H

10. Mahadevan, Design Data Hand Book

Programme Elective 3

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E203A	Computational Fluid Dynamics	Elective	4	0	0	4	4

Preamble: The Course aims to enable students to solve the governing equations of fluid flow using various numerical techniques. This learning may be used to solve practical fluid flow problems in engineering applications.

Prerequisite: Basic understanding of differential equations and numerical methods is assumed.

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

CO No	CO Statements	Cognitive Knowledge Level
CO 1	Derive the governing equations of fluid flow.	Understand
CO 2	Apply finite volume methods to solve convection diffusion transport problems.	Apply
CO 3	Solve flow fields for steady and unsteady flows	Apply
CO 4	Conduct practical CFD simulations.	Analyse
CO 5	Choose appropriate turbulence models	Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	1		3	1	2	1
CO 2	1		3	1	2	1
CO 3	1		3	1	2	1
CO 4	1		3	1	2	1
CO 5	1		3	2	2	1

Assessment Pattern

Bloom's Category	M24ME2T201		
	Continuous Assessment Tests		End Semester Examination (%Marks)
	Test 1 (%Marks)	Test 2 (%Marks)	
Remember	xx	xx	xx
Understand	20	20	20
Apply	50	50	50
Analyse	30	30	30
Evaluate	xx	xx	xx
Create	xx	xx	xx

Mark Distribution

Total Marks	CIE marks	ESE marks	ESE Duration
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

Module 1: (9 Hours)

Governing equations of fluid flow and heat transfer, Equations of state, Navier–Stokes equations for a Newtonian fluid, Conservative form of the governing equations of fluid flow, differential and integral forms of the general transport equations, classification of physical behaviours, the role of characteristics in hyperbolic equations, classification method for simple PDE's, classification of fluid flow equations

Module 2: (10 Hours)

Finite volume method for convection-diffusion problems, Steady one-dimensional convection and diffusion, Steady two-dimensional convection and diffusion, properties of discretisation schemes, the upwind differencing scheme, the hybrid differencing scheme, the power-law scheme, higher-order differencing schemes, TVD schemes

Module 3: (9 Hours)

Solution algorithms for pressure-velocity coupling in steady flows, the staggered grid, the momentum equations, the SIMPLE algorithm, the PISO algorithm, worked examples of the SIMPLE algorithm solution of discretised equations using TDMA, point-iterative methods, the finite volume method for unsteady flows: explicit scheme, Crank–Nicolson scheme & fully implicit scheme.

Module 4: (7 Hours)

Implementation of boundary conditions, inlet boundary conditions, outlet boundary conditions, wall boundary conditions, the constant pressure boundary condition, symmetry boundary condition, periodic boundary condition, errors and uncertainty in CFD, numerical errors, input uncertainty, physical model uncertainty, verification and validation, guidelines for best practice in CFD

Module 5: (10 Hours)

Turbulence and its modelling, descriptors of turbulent flow, turbulent flow calculations, Reynolds-averaged Navier–Stokes equations and classical turbulence models: mixing length model, the k–ε model, Reynolds stress equation models, advanced turbulence models, guidelines for choice of turbulence models

Reference Books

1. H K Versteeg & W Malalasekera , "An Introduction To Computational Fluid Dynamics", Pearson, 2008
2. Suhas V Patankar , "Numerical Heat Transfer And Fluid Flow", CRC Press, 2017
3. T. J. Chung , "Computational Fluid Dynamics" , Cambridge University Press, 2014

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic	No. of Lecture/ Tutorial hours
	Module 1 (9 Hours)	
1.1	Governing equations of fluid flow and heat transfer, Equations of state	1
1.2	Navier–Stokes equations for a Newtonian fluid	2
1.3	Conservative form of the governing equations of fluid flow	1
1.4	differential and integral forms of the general transport equations	1
1.5	Classification of physical behaviors	2
1.6	The role of characteristics in hyperbolic equations,	1
1.7	Classification method for simple PDE's, classification of fluid flow equations	1
	Module 2 (10 Hours)	
2.1	Finite volume method for convection-diffusion problems, Schemes for Steady one-dimensional convection and diffusion	1
2.2	Schemes for Steady two-dimensional convection and diffusion	1
2.3	Properties of discretisation schemes	1
2.4	The upwind differencing scheme	1
2.5	The hybrid differencing scheme	1
2.6	The power-law scheme	1
2.7	Higher-order differencing schemes	1
2.8	TVD schemes	1
2.9	Problems	2
	Module 3 (9 Hours)	

3.1	Solution algorithms for pressure-velocity coupling in steady flows	1
3.2	The staggered grid, the momentum equations	1
3.3	SIMPLE algorithm	1
3.4	PISO algorithm	1
3.5	TDMA	2
3.6	Worked out examples of the SIMPLE algorithm solution of discretised equations using TDMA	1
3.7	Point-iterative methods	1
3.8	Finite volume method for unsteady flows: explicit scheme, Crank–Nicolson scheme & fully implicit scheme.	1
	Module 4 (7 Hours)	
4.1	Implementation of boundary conditions, inlet boundary conditions, outlet boundary conditions, wall boundary conditions	1
4.2	Constant pressure boundary condition, symmetry boundary condition, periodic boundary condition	1
4.3	Errors and uncertainty in CFD	2
4.4	Numerical errors, input uncertainty, physical model uncertainty, verification and validation	1
4.5	Guidelines for best practice in CFD	2
	Module 5 (10 Hours)	
5.1	Turbulence and its modelling, descriptors of turbulent flow	1
5.2	Turbulent flow calculations, Reynolds-averaged Navier–Stokes equations	2
5.3	Classical turbulence models: mixing length model	1
5.4	The k–ε model	2
5.5	Reynolds stress equation models	1
5.6	Advanced turbulence models	2
5.7	Guidelines for choice of turbulence models	1

Model Question Paper

QP CODE:A Pages: 1

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

Second SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E203A**
Course Name: COMPUTATIONAL FLUID DYNAMICS

Max. Marks:60 Duration: 3 hours

PART A

Answer all questions. Each question carries 4 marks.

1. Write the governing equations of fluid flow
2. Using Taylor's series, derive second order difference expression for $\partial u/\partial y$
3. Define Peclet number. How does it influence the choice of convection diffusion schemes?
4. What is the utility of y+ value?
5. Define Kolmogorov scale. How is it influenced by Reynolds number?

PART B

Answer any five questions. Each question carries 8 marks.

6. From the governing equations of fluid flow, arrive at the general transport equation. Write the physical significance of each of the terms.
7. Explain TDMA algorithm. How is it significant to CFD algorithm?
8. Explain how the Navier Stokes equations are solved in the PISO method.
9. Assess the desirability of Central difference scheme for convection-diffusion problems against criteria of conservativeness, accuracy, transportiveness and boundedness.
10. Explain k-ω turbulence model.
11. Explain SIMPLE algorithm with a neat flowchart.
12. Derive the RANS equation. Explain why modeling is required in solving turbulent flows

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1E203B	**METROLOGY AND COMPUTER AIDED INSPECTION**	Elective	3	0	0	3	3

Preamble **:** This course helps the students to familiarize the basic concepts of metrology, use of statistics in metrology and types of errors in precision measurements. The course also covers the metrology of gears and methods of measurement in testing of machine tools and measurement of gears and Computer Aided Inspection (CAI) techniques.

Prerequisite **:Nil**

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

CO no.	CO Statements	Cognitive level Knowledge
CO 1	Understand the Mathematical concepts of Metrology	Apply
CO 2	Have up to date knowledge about Metrology and Inspection and their applications in industries	Apply
CO 3	Understand the role of computers in metrology	Apply
CO 4	To understand the recent trends in Metrology and Inspection	Understand
CO 5	To perform basic machine tool testing in industry	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2	2	2	1	1	1
CO 2	3	2	2	2	2	2
CO 3	1	1	2			1
CO 4	1	1	2	2	2	2
CO 5	1	1	2	2	2	2

Assessment Pattern

Course name	M24ME1E203B		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	30	30	30
Understand	30	30	30
Apply	20	20	20
Analyse	10	10	10
Evaluate	10	10	10
Create	0	0	0

Mark distribution

Total Marks	**CIA marks**	**ESE marks**	**ESE Duration**
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Seminar* : 10 marks

Course based task/Micro Project//Data collection and interpretation/Case study : 10 marks

Test paper 1 (Module 1 and Module 2) : 10 marks

Test paper 2 (Module 3 and Module 4) : 10 marks

*Seminar should be conducted in addition to the theory hours. Topics for the seminar should be from recent technologies in the respective course

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (8 hours)

Type of errors:-catastrophic errors, alignment errors, combined sine and cosine errors, alignment of spherical end gauges; optical principles of projector, microscope, telescope, collimator, autocollimator and optical flat etc ; errors due to ambient conditions and errors due to elastic deformation; effects of supports; scale, reading, measuring errors; compound errors.

Mathematical concepts in metrology: - statistical concepts, limiting mean, range, variance and standard deviation, normal distribution, confidence interval and limits, precision and accuracy, statistical analysis of measurement data and control chart techniques.

MODULE 2 (7 hours)

Pneumatic comparators: - general design features, air gauge circuits, air gauge tooling, amplification selection, air gauge mastering, automatic gauging for inspection, machine control and assembly.

Measurement of gears:-involute curve, involute function, standard proportions, helical gears, undercutting in gear teeth and addendum modification, dual flank test, single flank test -tooth thickness measurement:- tooth thickness at a pitch line, constant chord, base tangent method, measurement of over rollers - gear pitch measurement: - tooth to pitch measurement, cumulative pitch error measurement – testing involute form – allowable errors in spur gear.

MODULE 3 (6 hours)

Machine tool testing:- lathe tests:- spindle axis parallel to bed, cross slide perpendicular to spindle axis, accuracy of pitch of lead screw etc – milling machine tests:- table surface parallel to guide ways, center tee-slot parallel to table movement and square with spindle axis, cross travel of table parallel to spindle axis etc – radial drill tests:- saddle and arm movements parallel to base plate, spindle and feed movement square with base plate, other machines and methods.

MODULE 4 (9 hours)

Testing of measuring instruments:- plate square testing, angle between centerlines of holes, spines, gear tooth measurement, testing of try square, checking micrometer measuring faces, calibration of micrometer screw, checking of an autocollimator, optical square, calibration of polygon and circular table.x.

MODULE 5 (9 hours)

Laser metrology: Applications of lasers in precision measurements – Coordinate measuring machine – contact and non-contact CMM – causes of errors – accuracy specifications – contact and non-contact probes

- Calibration of CMM – measuring scales – Moiré fringes in linear grating – advantages and applications of CMM.
Machine vision system: Image formation – binary and grayscale image – image histogram – histogram operations – pixel point processing and pixel group processing – image sharpening and smoothing – edge detection and enhancement.

Text Books

1. ASME, Handbook of industrial metrology
2. Hume, “Metrology”, McDonald

Reference Books

1. Robert J. Hocken, Paulo H. Pereira, “Coordinate measuring machines and systems”, Second Edition, CRC
2. Sharp, “Metrology”, ELBS
3. Taher, “Metrology”, ELBS
4. Ted Busch, “Fundamentals of dimensional metrology”, Third Edition, Delmar Publishers

COURSE CONTENTS AND LECTURE SCHEDULE

No	Topic
1	**Module 1: Types of Errors and Mathematical Concepts in Metrology**
1.1	Type of errors:-catastrophic errors, alignment errors, combined sine and cosine errors, alignment of spherical end gauges; optical principles of projector, microscope, telescope, collimator, autocollimator and optical flat etc ; errors due to ambient conditions and errors due to elastic deformation; effects of supports; scale, reading, measuring errors; compound errors.
1.2	Mathematical concepts in metrology: - statistical concepts, limiting mean, range, variance and standard deviation, normal distribution, confidence interval and limits, precision and accuracy, statistical analysis of measurement data and control chart techniques.
2	**Module 2: Pneumatic Comparators and Measurement of Gears**

2.1	Pneumatic comparators: - general design features, air gauge circuits, air gauge tooling, amplification selection, air gauge mastering, automatic gauging for inspection, machine control and assembly.
2.2	Measurement of gears:-involute curve, involute function, standard proportions, helical gears, undercutting in gear teeth and addendum modification, dual flank test, single flank test -tooth thickness measurement:-tooth thickness at a pitch line, constant chord, base tangent method, measurement of over rollers - gear pitch measurement: - tooth to pitch measurement, cumulative pitch error measurement – testing involute form – allowable errors in spur gear.
3	**Module 3: Machine Tool Testing**
3.1	Machine tool testing:- lathe tests:- spindle axis parallel to bed, cross slide perpendicular to spindle axis, accuracy of pitch of lead screw etc – milling machine tests:- table surface parallel to guide ways, center tee-slot parallel to table movement and square with spindle axis, cross travel of table parallel to spindle axis etc – radial drill tests:- saddle and arm movements parallel to base plate, spindle and feed movement square with base plate, other machines and methods.
4	**Module 4: Testing of Measuring Instruments**
4.1	Testing of measuring instruments:- plate square testing, angle between centerlines of holes, spines, gear tooth measurement, testing of try square, checking micrometer measuring faces, calibration of micrometer screw, checking of an autocollimator, optical square, calibration of polygon and circular table.
5	**Module 5: Laser Metrology and Machine Vision System**
5.1	Laser metrology: Applications of lasers in precision measurements – Coordinate measuring machine – contact and non-contact CMM – causes of errors – accuracy specifications – contact and non-contact probes - Calibration of CMM – measuring scales – Moiré fringes in linear grating – advantages and applications of CMM.
5.2	Machine vision system: Image formation – binary and grayscale image – image histogram – histogram operations – pixel point processing and pixel group processing – image sharpening and smoothing – edge detection and enhancement.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain about combined sine and cosine errors.

2. Differentiate between dual flank test and single flank test.

3. Briefly explain different types of lathe tests.

Course Outcome 2 (CO2)

1. Describe various types of pneumatic comparators.

2. Discuss about various types of errors in metrology.

3. Explain the principle and constructional features of an autocollimator in detail.

Course Outcome 3 (CO3)

1. Explain about radial drill tests in detail.

2. Explain about the calibration of an autocollimator in detail.

3. Explain about binary and grayscale images in detail.

Course Outcome 4 (CO4)

1. Explain about Laser metrology in detail.

2. What do you mean by image histogram?

3. Briefly explain the machine vision system.

Course Outcome 5 (CO5)

1. Explain about radial drill tests in detail.

2. What do you mean by lathe test?

3. Briefly explain the milling machine test.

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: **M24ME1E203B**

Course Name: **METROLOGY AND COMPUTER AIDED INSPECTION**

Max. Marks:60 Duration: 3 hours

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain about combined sine and cosine errors.
2. Differentiate between dual flank test and single flank test.
3. Briefly explain different types of lathe tests.
4. Explain about calibration of polygon and circular table.
5. Differentiate between contact and non contact CMM.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Explain about errors due to ambient conditions and errors due to elastic deformation.
7. Explain general design features of pneumatic comparators.
8. Explain about radial drill tests in detail.
9. Explain about the calibration of an autocollimator in detail.
10. Explain about binary and grayscale images in detail.
11. Discuss calibration of CMM in detail.
12. Explain plate square testing with a neat sketch.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
M24ME1E203C	MICRO AND NANO MACHINING	PEC	3	0	0	3

Preamble:

This course helps students to discuss the various manufacturing processes of MEMS and semiconductor devices and to study size-effects and material/interface behavior at the micro-/nano scale. It also enables students to study the structure, properties and applications of carbon based nanostructures.

Course Outcomes:

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

CO no.	CO Statements	Cognitive level Knowledge
CO 1	A good understanding of the fundamentals associated with manufacturing and machining at the micro and nano scale	Apply
CO 2	In depth knowledge of micro and nano structures and their processing methods and techniques	Apply
CO 3	To gain depth knowledge in carbon nanotube production and applications	Understand
CO 4	In depth knowledge of photolithography and its applications	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	2			2	
CO 2	2	2	2			2	
CO 3	2	2	2	1	1	2	
CO 4	2	2	2	1	1	1	

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	30%
Understand	30%
Apply	20%
Analyze	10%
Evaluate	10%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

● Preparation of a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	**:** 15 marks
● Course based task/seminar/data collection and interpretation	: 15 marks
● Internal test – 1 No (Portion for test: Minimum 80% of the syllabus)	: 10 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 1 question from each module and having 5 marks for each question. Students should answer all questions. Part B contains 7 questions from each module of which a student should answer any 5 questions. Each question carries 7 marks and can have a maximum of 2 subdivisions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss about the basics of micromachining and microfabrication.

2. Explain the masking for anisotropic etchants.

3. Explain the principle of micro contact printing and applications.

Course Outcome 2 (CO2)

1. Discuss the structure of Fullerene.

2. Explain about properties of carbon nanostructures.

3. List the 15 potential applications of nanostructures.

Course Outcome 3 (CO3)

1. Explain about the structure of carbon nanotubes.
2. Explain about purification of carbon nanotubes.
3. Discuss the electrical transport of carbon nanotubes for FET.

Course Outcome 4 (CO4)

1. Explain about the principle of soft lithography.
2. List down the applications of photolithography.
3. Differentiate between isolation layer and sacrificial layer.

Model Question paper

Reg. No.: ..... Name:.....

A

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Subject Code: M24ME1E203C

Subject Name: MICRO AND NANO MACHINING

Time: 2.5 hrs. Max. Marks: 60

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain the basics of micro fabrication.
2. Explain the general principle of the soft lithography and applications.
3. Briefly explain about micro FEEP.
4. Explain about chemical vapor deposition.
5. Explain the structure of carbon nanotubes.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Explain about fabrication of a cantilever probe in detail.
7. Explain the principle of micro contact printing and applications in detail.
8. Explain about subsystems and devices for miniaturized spacecraft micro propulsion.
9. Explain about the purification of carbon nanotubes in detail.
10. Explain about the structure of carbon nanoballs structure of carbon nanofibers in detail.
11. Discuss laser ablation in detail with a neat sketch.

12. Explain about nano particles in heterogeneous catalysis.

Syllabus and Course Plan

No	Topic	No. Of Lectures
1	**Module 1: Manufacturing processes of MEMS and semiconductor devices**	**8 hrs**
1.1	Characterizing etching processes in bulk micromachining -micro fabrication of MEMS and semiconductor devices -basics of micro fabrication, integrated circuit fabrication etc - crystallography and its effects, silicon as substrate and structural material - crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, microprocessors etc and applications.	8 hrs
2	**Module 2: Photolithography**	**6 hrs**
2.1	Photolithography: Principle of the soft lithography and applications - principle of micro contact printing and applications - characterizing the Surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress and strain measurement, stiction.	6 hrs
3	**Module 3: Wafer Bonding**	**6 hrs**
3.1	Wafer bonding: anodic and fusion, bonding. Micro and nanotechnology: Applications for space micro propulsion - subsystems and devices for miniaturized spacecrafts micro propulsion: microbolometer, micro FEEP, integrated cold-gas micro thruster, micro turbogas, pyrotechnic actuator and micro valve etc - propulsion systems: solid propellant, ADCS etc.	6 hrs
4	**Module 4: Carbon nanotubes production and applications**	**8 hrs**
4.1	Carbon nanotubes production and applications: Basis of nanotechnology - structure and properties of carbon nanotubes- production of carbon nanotubes: chemical vapor deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nanotubes – applications: electrical transport of carbon nanotubes for FET, Computers, nanodevices	8 hrs

	for biomedical, X-ray equipment, nanomechanical actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage etc.	
5	**Module 5: Carbon based nanostructures**	**8 hrs**
5.1	Carbon based nanostructures: - Structure of carbon nanotubes, Y-shaped, Double helical, bamboo, hierarchical morphology - structure of fullerenes - structure of carbon nanoballs structure of carbon nanofibers - porous carbon - properties of carbon nanostructures – synthesis - 15 potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nano particles in heterogeneous catalysis, O2 electro reduction reaction on carbon supported Pt catalysts, carbon nanotubes as catalyst supports.	8 hrs

Reference Books

1. Nitaigour Premchand Mahalik, “Micromanufacturing and nanotechnology”, Springer.
2. M. Kahrizi, “Micromachining techniques for fabrication of micro, nano structures”.
3. Mark J. Jackson, “Micro and nanomanufacturing”, Springer
4. Jeremy Ramsden, “Micro & nano technologies”, Elsevier.

Programme Elective 4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
M24ME1E204A	FINITE ELEMENT METHODS	PEC	3	0	0	3

Preamble:

This course helps students in basic understanding of FEA, Preprocessing, solution and post processing. It also gives basic concepts of discretization of solution domain into a finite element mesh, assembly of element equations and boundary condition, solution for nodal unknowns and derived quantities over each element and finite element mesh refinement and convergence. This course provides implementation and application of FEM in 1-D, 2-D and 3D static and dynamic structural analysis and heat conduction.

Course Outcomes:

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

CO no.	CO Statements	Cognitive level Knowledge
CO 1	Understand the fundamental ideas of the FEM like meshing, solution and post processing	Apply
CO 2	Know the behavior and usage of each type of elements covered in this course	Understand
CO 3	Be able to prepare a suitable FE model for structural mechanical analysis problems	Apply
CO 4	Be able interpret and evaluate the quality of the results	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	3	2	2	2	
CO 2	3	2	3	1	1	2	
CO 3	2	2	3	2	2	2	
CO 4	2	2	3	2	2	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	20%
Understand	20%

Apply	20%
Analyze	20%
Evaluate	10%
Create	10%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

● Preparation of a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	**:** 15 marks
● Course based task/seminar/data collection and interpretation	: 15 marks
● Internal test – 1 No (Portion for test: Minimum 80% of the syllabus)	: 10 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 1 question from each module and having 5 marks for each question. Students should answer all questions. Part B contains 7 questions from each module of which a student should answer any 5 questions. Each question carries 7 marks and can have a maximum of 2 subdivisions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss about the basic concepts of FEM.

2. Classify boundary conditions in detail.

3. What is meant by post processing?

Course Outcome 2 (CO2)

1. Explain important properties of CST elements.

2. Define LST element.

3. Classify different types of elements used in FEM.

Course Outcome 3 (CO3)

1. Develop the expression of the stiffness matrix for the truss element.

2. Determine the element mass matrix for 1-D dynamic structural analysis problem.

3. Develop stiffness matrix equation for 1-D heat conduction element.

Course Outcome 4 (CO4)

1. Why is it difficult to analyze plane stress elasticity?

2. How can an accurate representation of irregular domains be accomplished?

3. How can I interpret results in FEM?

Model Question paper

Reg. No.: ..... Name:.....

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M. TECH DEGREE EXAMINATION, DECEMBER 2024

M24ME1E204A– FINITE ELEMENT METHOD

Time: 2.5 hrs. Max. Marks: 60

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain the basic concepts of FEM.
2. Briefly explain about the patch test.
3. Briefly explain about practical Considerations in Modeling.
4. Differentiate between CST and LST elements.
5. Briefly explain about isoparametric formulation.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Derive the stiffness matrix for linear bar finite elements.
7. Explain about different types of refinements in detail.
8. Derive the Plane Stress and Plane Strain Stiffness Equations for 2-D elements.
9. Derive stiffness matrix for CST 2-D element.
10. Derive natural coordinates system for 1-D line element.
11. Derive interpolation function for an isoparametric element.
12. Explain method of weighted residuals (Galerkin) with an example.

Syllabus and Course Plan

No	Topic	No. Of Lectures
1	**Module 1**	**8 hrs**
1.1	Matrix algebra in FEM, Methods of solution of simultaneous equations, Basic concepts of FEM, Virtual work and variational methods, Introduction to the Stiffness (Displacement) Method, Spring, Bar elements and torsion element, Development of truss equations (Stiffness matrix, load vectors)	8 hrs
2	**Module 2**	**8 hrs**
2.1	Development of Euler beam equations, Frame and grid equations, Transformation of coordinates, Interpolation functions for general element formulation. Patch test, different type of refinements (h, p and r)	8 hrs
3	**Module 3**	**8 hrs**
3.1	Development of the Plane Stress and Plane Strain Stiffness Equations, Practical Considerations in Modeling, Interpreting Results and Examples of Plane Stress/Strain Analysis	8 hrs
4	**Module 4**	**8 hrs**
4.1	Development of the CST, Linear-Strain Triangle Equations, Method of weighted residuals (Galerkin), Boundary conditions (Neumann, Dirichlet and Robin), Plate Bending Element	8 hrs
5	**Module 5**	**8 hrs**
5.1	Axisymmetric Elements, Natural coordinates systems, Isoparametric Formulation, Three-Dimensional Stress Analysis, Lagrange and Serendipity Elements, Structural Dynamics, Mass matrix computation, Evaluation of Eigenvalues and Eigenvectors, Modal space	8 hrs

Reference Books

1. Fundamentals of FEM by David V Hutton, McGraw Hill
2. A First Course in the Finite Element Method Fifth Edition - Daryl L. Logan - Thomson
3. An introduction to the Finite Element Method, 3rdEdn. Reddy J. N.
4. Finite element procedures K. J. Bathe, PHI
5. The Finite element methods in engineering, S S Rao
6. Introduction to finite elements in engineering, T. R.Chandrupatla and Ashok D. Belegundu PHI
7. Elementary Finite Elements Method, Desai C. S.
8. The Finite Element Method, Zienkiewicz O. C.
9. Applied finite element analysis, Larry J.Segerlind
10. Finite Element Method, R. D. Cook
11. Finite Element Method, C.S. Krishnamurthy
12. Basics of FEM- Solid Mechanics, Heat transfer and Fluid mechanics, Dubuque I A and W C Brown.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
M24ME1E204B	STATISTICAL METHODS FOR ENGINEERS	Elective	3	0	0	3

Preamble:

This course introduces the concepts of experimental design and applications. It also discusses reliability assessment and reliability testing and various models in multivariate analysis. This course helps students to become familiar with correlation and regression analysis.

Course Outcomes:

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

CO no.	Course Outcome statements	Cognitive knowledge level
CO 1	Students should understand the use of statistical methods necessary to conduct statistical Analyses for research.	Apply
CO 2	Students should possess the skills to apply statistical models to a wide variety of real life Problems.	Apply
CO 3	Students should be able to provide correct interpretations from a set of analyses and Include any limitations.	Apply
CO 4	Students should understand the fundamental concepts of introduction to machine learning	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	2	3	3	2	
CO 2	2	2	2	3	3	2	
CO 3	2	2	2	3	3	2	
CO 4	2	2	2	1	1	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	20%
Understand	20%
Apply	20%
Analyze	20%
Evaluate	10%
Create	10%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

● Preparation of a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	**:** 15 marks
● Course based task/seminar/data collection and interpretation	: 15 marks
● Internal test – 1 No (Portion for test: Minimum 80% of the syllabus)	: 10 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 5 questions with 1 question from each module and having 5 marks for each question. Students should answer all questions. Part B contains 7 questions from each module of which a student should answer any 5 questions. Each question carries 7 marks and can have a maximum of 2 subdivisions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What do you mean by analysis of variance?

2. State the definition and importance of reliability.

3. Differentiate between correlation and regression analysis.

Course Outcome 2 (CO2)

1. Explain the two types of errors in testing hypotheses.

2. Define factor and level in factorial design with an example.

3. Define partial correlation with an example.

Course Outcome 3 (CO3)

1. How efficiency is identified in the criteria of estimation?

2. Give an example of trivariate data in engineering applications.

3. Give an example of a covariance matrix and identify the variance in it.

Course Outcome 4 (CO4)

1. What do you mean by cluster analysis?

2. Differentiate between correlation and regression analysis.

3. Explain rank order clustering algorithm with example.

Model Question paper

Reg. No.: ..... Name:.....

A

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

M24ME1E204B– STATISTICAL METHODS FOR ENGINEERS

Time: 2.5 hrs. Max. Marks: 60

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 5 MARKS)

1. Explain basic principles of experimental designs.

2. State the difference between reliability and quality.

3. List down the objectives of reliability testing.

4. Calculate the regression coefficient and obtain the lines of regression for the following data

X	1	2	3	4	5	6	7
Y	9	8	10	12	11	13	14

5. Distinguish between principal component and factor analysis.

PART – B
(ANSWER ANY FIVE FULL QUESTIONS, EACH QUESTION CARRIES 7 MARKS)

6. Give the analysis of 2^3 experiments using an RBD.

7. Draw and explain Bathtub Curves.

8. Find out the system reliability for a serial and parallel configuration with 2 components.

9. A research physician recorded the pulse rates and the temperatures of water submerging the faces of ten small children in cold water to control the abnormally rapid heartbeats. The results are presented in the following table. Calculate the correlation coefficient between temperature of water and reduction in pulse rate.

Temperature of water	68	65	70	62	60	55	58	65	69	63
Reduction in pulse rate.	2	5	1	10	9	13	10	3	4	6

10. Explain the different types of correlations with examples.

11. In Principal component analysis derive the first principal component.

12. Explain the principal component (principal factor) method of estimating L in the factor analysis model.

Syllabus and Course Plan

No	Topic	No. Of Lectures
1	**Module 1: Design of experiments**	**8 hrs**
1.1	Design of experiments: Analysis of variance - completely randomized design - randomized complete block design - Latin square design – Ducan's multiple range tests. Factorial design: 2^n factorial design – 2^2 and 2^3 factorial design - Yates' algorithm for 2n factorial experiment.	8 hrs
2	**Module 2: Reliability assessment**	**8 hrs**
2.1	Reliability assessment: Definition and importance of reliability - pattern of failures - factor of safety and reliability - reliability management. Time Dependent reliability of components and systems - failure rate time curve - series and parallel systems - (k, n) systems, complex systems. Strength based reliability and inference theory.	8 hrs
3	**Module 3: Reliability testing**	**8 hrs**
3.1	Reliability testing: Objectives of reliability test - details of reliability tests - analysis of failure time - accelerated life testing - sequential life testing - statistical inference and parameter estimation - confidence intervals - plotting of reliability data.	8 hrs
4	**Module 4: Correlation and Regression Analysis**	**8 hrs**
4.1	Correlation Analysis: Karl Pearson's correlation, Spearman's rank correlation, Autocorrelation. Regression Analysis: Simple and Multiple Regression models, Determination of regression coefficients, Coefficient of determination, Significance test of Regression model.	8hrs

5	Module 5: Multivariate methods	8 hrs
5.1	Multivariate methods: Discriminant analysis – two-group and multiple Discriminant analysis. Factor analysis – terminologies – methods of factor analysis. Cluster analysis – concepts – similarity measures – clustering techniques – hierarchical clustering algorithm – rank order clustering algorithm.	8 hrs

Reference Books

1. Paneerselvam, R., "Research methodology", Prentice Hall of India, New Delhi, 2011
2. Montgomery, D. C., "Design and analysis of experiments", John Wiley and Sons, New York, 2008
3. Gardiner, W. P. and Gettinby, G., "Experimental design techniques in statistical practice: A practical software-based approach", Horwood Publishing Limited, Chichester, 1998
4. Rao, S. S. "Reliability-based design", McGraw Hill, 1992.
5. Kapur, K. C. and Lamberson L. R., "Reliability in engineering design", John Wiley and Sons, New York, 1977
6. Srinath, L. S., "Reliability engineering", Affiliated East West Press Pvt Ltd, New Delhi, 1998.
7. A. B. Bowker and G. J. Liberman, "Engineering Statistics", Asia, 1972
8. J.K. Sharma, "Business Statistics", Pearson Education
9. Hair et al., "Multivariate Data Analysis", Pearson Education
10. Amir D Aczel and Jayavel Sounderpandian, "Complete Business Statistics", Tata McGraw-Hill

M24ME1E204C	MANUFACTURING METHODS AND MECHANICS OF COMPOSITES	CATEGORY	L	T	P	CREDIT
		Programme Elective	3	0	0	3

Preamble:

To enable the student to understand and analysis aspects of composite materials including advanced materials such as nano composites. This will include the concepts such as anisotropic/orthotropic materials behaviour and the analysis of composite materials.

Course Outcomes: At the end of the course students will be able to

CO no.	Course Outcome Statements	Cognitive knowledge level
CO 1	Classify different types of polymers, reinforcements and composites.	Apply
CO 2	Understand the fundamental properties and applications of composite materials	Understand
CO 3	Explain the various processing techniques of PMCs, MMCs, CMCs and nano composites.	Apply
CO 4	Apply the knowledge of failure theories for designing the composite materials.	Apply
CO 5	Design and analysis of various types of composite materials.	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	2	2	1	1	
CO 2	2	2	3	2	1	1	
CO 3	2	2	3	2	2		
CO 4	3		3	3	2	1	

CO 5			3	3	3	1	2

Assessment Pattern

Bloom's Category	End Semester Examination
Remember/Understand	30 %
Apply	20 %
Analyse	20 %
Evaluate	20 %
Create	10 %

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: Programme Elective

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed
Original publications (minimum 10 publications shall be referred): 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper – 1No. (Test paper shall include minimum
80% of the syllabus) : 10 marks

End Semester Examination Pattern: (60 Marks)

The end semester examination will be conducted by the respective College for Programme Electives. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model question paper

Name:
Reg. No:

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM

SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

M24ME1E204C Manufacturing Methods and Mechanics of Composites

Time: 2.5 hours **Max. Marks: 60**

PART A

(Answer all the five questions from Part 'A')

Q. No.	Module 1	Marks
1.	Define composite material. Mention important characteristics of composite material.	**5**
	Module 2	
2.	Explain filament winding with neat sketch. Mention any two products made up of this technique.	**5**
	Module 3	
3.	What do you mean by in-situ process? Explain its advantages and disadvantages.	**5**
	Module 4	
4.	Explain Von misses yield criterion for isotropic material.	**5**
	Module 5	
5.	Discuss on Environmental degradation of composites	**5**

PART B

(Answer any five questions from Part 'B')

1. Explain the prospects and limitations in using composites as a replacement with regard to aerospace, marine and biomedical applications. **7**

2. Ductility, the ability to deform plastically in response to stresses, is more of characteristics of metals than it is of ceramics or polymers. Why? **7**

3. What are the processing methods used for polymer matrix composites? Explain any two of them with neat sketch. **7**

4. Compare liquid infiltration and slurry infiltration process in manufacturing ceramic matrix composites. **7**

5(a). Derive the expression for the composite longitudinal strength.

(b). A thermoplastic matrix contains 40 wt.% glass fiber. If the density of the matrix, ρ_m, is 1.1 g/cm^3 while that of glass fiber, ρ_f, is 2.5 g/cm^3, what is the density of the composite? Assume that no voids are present. **7**

6. Write short note on Tsai-Hill's failure criterion. And compare it with the maximum stress and strain criteria. **7**

7. Elaborate about unidirectional off axis orthotropic lamina. **7**

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**MODULE:1**	
1.1	Composite materials: Definition –Need – General characteristics Matrices: Thermoplastics-Raw materials, Thermosets, Unsaturated polyester resin, Alkyd resin, Vinyl ester, Polyamides, Metal and ceramic matrix composites, Nanocomposites	3
1.2	Reinforcements: Types, Properties, Uses of silica, Titanium dioxide, Talc, Mica, etc., Flake, Fibres -Structure, Property and applications of	3

	various types of fibres, Coupling agents, Repairs and maintenance, Composite joints.	
1.3	Application of Composites - Aerospace, Transport, Marine, Structural, Chemical, Sports, Electrical, Electronic, Communication, Biomedical applications	2
2	**MODULE: 2**	
2.1	Processing: Thermoplastic, Thermosets, etc., Types of methods, Processing conditions advantages and disadvantages, Film forming, Lamination, Sandwich, etc., Hand layup methods, compression and transfer moulding.	3
2.2	Pressure and vacuum bag process, Filament winding, Spin coating, Pultrusion, Injection moulding of thermosets	3
2.3	Reinforced RIM (reaction IM), SMC (sheet moulding) and DMC (dough moulding).	2
3	**MODULE: 3**	
3.1	Liquid and solid state and in-situ processes for metal matrix composites	3
3.2	Liquid and solid state and in-situ processes for Ceramic matrix composites	3
3.3	Liquid and solid state and in-situ processes for nano composite materials.	3
4	**MODULE:4**	
4.1	Constitutive equations- Generalised Hooke's law, stiffness and compliance matrices. Evaluations of lamina properties from laminate tests, Quasi - isotropic laminates. Determination of lamina stresses within laminates	4
4.2	Lamina strength analysis: Introduction, Maximum stress and strain criteria, Von-Misses yield criterion for isotropic materials	4
5	**MODULE: 5**	
5.1	Generalized Hill's criterion for anisotropic materials, Tsai-Hill's failure criterion - Tensor polynomial (Tsai-Wu) failure criterion, First ply failure theory	3
5.2	Mesoscale composite damage theory based on continuum damage mechanics - Prediction of laminate Failure - Environmental degradation of composites	3
5.3	Orthotropic lamina – Unidirectional, off-axis, Symmetric balanced laminates, Thermally quasi-isotropic laminates.	3

References

1. R. M. Jones,- Mechanics of Composite Material, McGraw Hill Publishing.

2. B. D. Agrawal and L.J. Brountman, Analysis and Performance of Fiber Composite, Willey New York, 1980.
3. Mallick, P.K., “Fiber-Reinforced Composites: Materials, manufacturing and design”, Maneel Dekker Inc, 1993
4. Autar K Kaw, “Mechanics of Composite Materials”, CRC Press, 2006
5.Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 2/E
6.Mukhopadhyay.M, “ Mechanics of Composite Materials and Structures”, University Press, India, 2004
7.Daniel and Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press, 2005
8.Bharath Bhusan, Springer Handbook of Nanotechnology, 3rd edition, Springer- Verlag (2009)

Industry Integrated Course
(Integrated with STAMTEK)

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1S205	DESIGN AND SIMULATION OF PRODUCTION TOOLING AND MANUFACTURING SYSTEM	Core	3	0	0	3	3

Preamble:

This course focuses on the key topics of tools and simulation of manufacturing systems . This course aims to provide a comprehensive understanding of the principles and practices involved in the creation and optimization of production tools and manufacturing systems. The design of production tooling is a crucial intermediate stage in the development of efficient and reliable manufacturing processes. By designing and simulating production tools, students will learn to predict the performance and quality of manufacturing systems

Prerequisite: nil

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

CO no.	CO statements	Cognitive Knowledge level
CO 1	Design single point cutting tool, form tool, drill etc	Apply
CO 2	Understand how to conduct machining economically	Apply
CO 3	Design jigs, fixtures and press tools	Apply
CO 4	Model and simulate using ARENA,SIMQUICK,WITNESS, Flexsim	Understand
CO 5	Simulate job shop system and queuing system	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		3	3		
CO 2	3		3	3		
CO 3	3		3	3	2	

CO 4	3		2	3	1	
CO 5	3		3	3	1	

Assessment Pattern

Bloom's Category	**ADVANCED WELDING AND CASTING**		
	Continuous Assessment Tests		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	25	25	25
Understand	15	15	15
Apply	30	25	30
Analyse	10	10	10
Evaluate	10	15	10
Create	10	10	10

Mark distribution

Total Marks	**CIA marks**	**ESE marks**	**ESE Duration**
100	40	60	3 Hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project :10 marks

Course based task/Seminar/Quiz :10 marks

Test paper 1 (Module 1 and Module 2) :10 marks

Test paper 2 (Module 3 and Module 4) :10 marks

End Semester Examination Pattern: The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 4 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 8 marks. Total duration of the examination will be 3 Hrs.

SYLLABUS

MODULE 1 (9 hours)

Design of cutting tools: Tool materials, design of single point cutting tool, form tool, drill, reamer, broach & plain milling cutter. Theory of metal cutting – design of tool holders for single point tools – Boring bars – selection of tools for machining applications – economics of machining

MODULE 2 (6 hours)

Design of fixtures: standard work holding devices – principles of location and clamping – clamping methods and elements – quick-acting clamps – design & sketching of milling fixtures for simple components – Turning, Grinding, Welding fixtures. inspection fixtures and design of gauges Design of Drill jigs: Drill bushings – types of jigs: Plate, Leaf, Turn over & Box Jigs – design & sketching of drill jigs for machining simple components

MODULE 3 (8 hours)

Press tools: power presses – die cutting operations – centre of pressure – scrap strip lay out for blanking – press tonnage calculations – Progressive & Compound dies – die design for simple components. Drawing dies – blank development – estimation of drawing force – blank holders & blank holding pressure – design & sketching of drawing dies for simple components – Bending dies & Combination tools..

MODULE 4 **(9 hours)**

Components of a system, Types of models, Monte Carlo Simulation, Steps in simulation, applications -Discrete Event Simulation – components of DES - Time advance mechanism. Introduction – probability mass function, probability density function, Statistical models – Discrete distributions – Bernoulli, Binomial, Poisson, Geometric-Continuous distributions – Normal, Uniform, Exponential Gamma, Triangular Empirical Distributions

MODULE 5 (9 hours)

Input Analysis Methods-Examples-Verification of simulation models- Validation of simulation models-Measure of performance and their estimation-Out put Analysis Methods-Transient and steady state behavior – Evaluation of alternate system design – Simulation Based Optimization (SBO). Simulation packages spreadsheet, witness, Arena etc., Simulation of queuing models, inventory models, Material handling, assembly systems, logistics and supply chains.

Text Books

1. Cyril Donaldson, Lecain and Goold: Tool Design – Tata Mc Graw Hill publications

2. Banks, Carson, Nelson and Nicol : Discrete-Event System Simulation, Fourth Edition Prentice Hall of India ,200

Reference Books

1. ASTME: Fundamentals of Tool Design – Prentice Hall 2. F W Wilson: Hand Book of Fixture Design - Mc Graw Hill publications

2. Scanning Electron Microscopy and X-Ray Microanalysis: Joseph I. Goldstein, Dale E. Newbury, Joseph R. Michael, Nicholas W.M. Ritchie, John Henry J. Scott, David C. Joy, 4th Edition, Springer 2017

3. A. M. Law and W. D. Kelton: Simulation, Modeling and Analysis, Third Edition, McGraw-Hill,2000.

4. .Geoffrey Gordon: System simulation, second edition Prentice Hall of India

COURSE CONTENTS AND LECTURE SCHEDULE

(For 4 credit courses, the content can be for 45 hrs. and for 3 credit courses, the content can be for 36 hrs.)

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Design of cutting tools: Tool materials, design of single point cutting tool,	2
1.2	Design of form tool, drill, reamer, broach & plain milling cutter.	1
1.3	Theory of metal cutting – design of tool holders for single point tools	2
1.4	Design of Boring bars – selection of tools for machining applications – economics of machining	3
2	**Module 2**	
2.1	Design of fixtures: standard work holding devices – principles of location and clamping – clamping methods and elements	2
2.2	Quick-acting clamps – design & sketching of milling fixtures for simple components	2
2.3	Turning, Grinding, Welding fixtures. inspection fixtures and design of gauges Design of Drill jigs	1
2.4	Drill bushings – types of jigs: Plate, Leaf, Turn over & Box Jigs – design & sketching of drill jigs for machining simple components	1
3	**Module 3**	
3.1	Press tools: power presses – die cutting operations –centre of pressure – scrap strip lay out for blanking	4
3.2	press tonnage calculations – Progressive & Compound dies – die design for simple components. Drawing dies – blank development	1
3.3	Estimation of drawing force – blank holders & blank holding pressure	2
3.4	Design & sketching of drawing dies for simple components – Bending dies & Combination tools.	1
4	**Module 4**	

4.1	Components of a system, Types of models, Monte Carlo Simulation, Steps in simulation, applications -Discrete Event Simulation – components of DES	1
4.2	Time advance mechanism. Introduction – probability mass function, probability density function, Statistical models – Discrete distributions	2
4.3	Bernoulli, Binomial, Poisson, Geometric- Continuous distributions – Normal, Uniform, Exponential Gamma, Triangular Empirical Distributions	2
4.4	**Case Study 1:** Simulation of Single Server Queuing System	2
4.5	**Case Study 2:** Simulation of Multiple Servers Queuing System	2
5	**Module 5**	
5.1	Input Analysis Methods-Examples-Verification of simulation models- Validation of simulation models	2
5.2	Measure of performance and their estimation-Out put Analysis Methods-Transient and steady state behavior – Evaluation of alternate system design – Simulation Based Optimization (SBO)	1
5.3	Evaluation of alternate system design – Simulation Based Optimization (SBO)	1
5.4	Simulation packages spreadsheet, witness, Arena etc., Simulation of queuing models, inventory models, Material handling, assembly systems, logistics and supply chains	2
5.5	**Case Study 3:** Simulation of Manufacturing and material handling systems	2
5.6	**Case Study 4:** Simulation of multi machine assignment system	1

Model Question Paper

QP CODE: Pages: X

Reg No.:_____

Name:_____

MAR ATHANASIUS COLLEGE OF ENGINEERING (AUTONOMOUS), KOTHAMANGALAM
SECOND SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2024

Course Code: M24ME1S205
COURSE NAME: DESIGN AND SIMULATION OF PRODUCTION TOOLING AND MANUFACTURING SYSTEM

Answer any five questions. Each question carries 12 marks.

Max. Marks:60 Duration: 3 hours

Part A

(Answer all questions. Each question carries 5 marks).

(Answer Any five questions. Each question carries 7 marks)

1. Discuss the importance of jigs and fixtures, the factors to consider when designing them (such as material selection, tolerance, and ergonomics), and how they contribute to the efficiency and accuracy of the manufacturing process.
2. Explain how CAD and CAM tools are used in the design and manufacturing of production tooling, their benefits in improving accuracy and efficiency, and provide examples of how these technologies are applied in real-world scenarios.
3. Explain the steps involved in conducting an FMEA, its importance in identifying potential failure modes in tooling design, and how it helps in developing strategies to mitigate risks and improve tool reliability.
4. Outline the steps involved in die design, including material selection, the design of die components (e.g., punch, die block, stripper plate), and considerations for ensuring the precision and durability of the die in high-volume production.
5. Discuss how simulation helps in understanding and improving manufacturing systems, including its role in

predicting system performance, identifying bottlenecks, and evaluating different scenarios for process improvement.

6. Compare and contrast discrete-event simulation, continuous simulation, and hybrid simulation models, highlighting their applications, advantages, and limitations in the context of manufacturing systems.
7. Compare and contrast discrete-event simulation, continuous simulation, and hybrid simulation models, highlighting their applications, advantages, and limitations in the context of manufacturing systems.

CODE	COURSE NAME	CATEGORY	L	T	P	S	CREDIT
M24ME1T206	COMPUTATIONAL ENGINEERING LAB	Laboratory	0	0	2	2	1

Preamble : The objective of this course is to provide a broad understanding of the structure of soft wares used for engineering analysis. This course will aid students in applying finite element methods, computational fluid dynamics and soft computing techniques to solve production engineering problems.

Prerequisite: Nil

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

CO no.	CO Statements	Cognitive Knowledge Level
CO 1	Explain the structure of a computer program used for numerical analysis	Apply
CO 2	Analyse linear and non linear problems using finite element analysis	Apply
CO 3	Analyse coupled problem using finite element analysis	Apply
CO4	Analyse fluid flow problems using computational fluid dynamics	Apply
CO 5	Create programs using genetic algorithm and fuzzy logic and apply ANN programs for solving engineering problems	Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	3	3	3	
CO 2	3	2	3	3	3	
CO 3	3	2	3	3	3	
CO 4	3	2	3	3	3	
CO 5	3	2	3	3	3	

Mark distribution

Total Marks	CIA Marks
100	100

Continuous Internal Evaluation Pattern:

Lab work and Viva-voce	: 60 marks
Final assessment Test and Viva voce	: 40 marks

The laboratory courses will be having only Continuous Internal Evaluation and carries 100 marks. Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

SYLLABUS

LIST OF EXPERIMENTS

1) Finite Element Analysis - Introduction to FEA software's:
• One dimensional problem using Matlab
• Two dimensional problem using FEA software
• Heat transfer problem using FEA software
• Coupled problems using FEA software
• Non linear problems using FEA software
2) Computational Fluid Dynamics - Introduction to CFD software's:
• 2D simulation of internal and external flow
• 3D simulation of flow with heat transfer
• Simulation of natural convection problem
3) Soft Computing:
Development of algorithms and computer programs using C /C++/Matlab
for decision problems using soft computing techniques.
• Genetic Algorithm
• Simulated Annealing
• Tabu search
• Fuzzy logic
• Artificial Neural Network

Reference Books

1.1. Saeed Moaveni, Finite Element Analysis: Theory and application with ANSYS,

Pearson Education, 2011

2. W.Y.Yang, W.Cao, T. Chung and J. Morris, Applied Numerical Methods Using

Matlab, Wiley, 2007

3. J.Tu, G.Yeoh and C. Liu, Computational Fluid Dynamics: A Practical Approach,

Butterworth Heinemann, 2012

4. Deb, K, Optimization for Engineering Design, Prentice Hall of India (P) Ltd.,