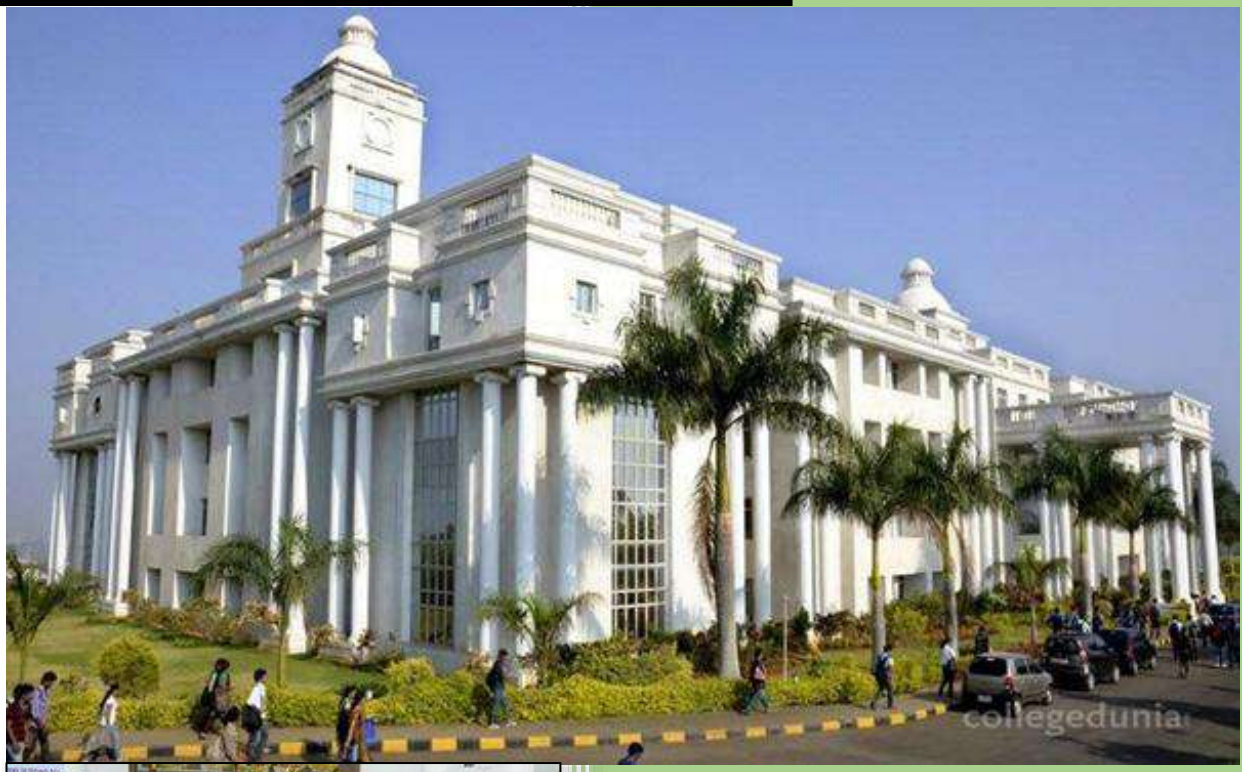
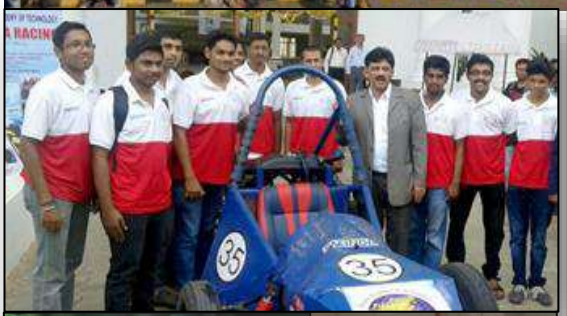
III - VIII Semester Scheme & Syllabus (2022) Department of MECHANICAL ENGINEERING

SCHEME AND SYLLABUS





Department of
MECHANICAL ENGINEERING

GLOBAL ACADEMY OF TECHNOLOGY
(Autonomous institution affiliated to VTU, Belagavi.
Accredited by NAAC with 'A' grade,
NBA Accredited CS, E&C, E&E, MECH and IS branches)
IDEAL HOMES TOWNSHIP,
RAJA RAJESHWARI NAGAR,
BENGALURU - 560098

Head of Department
Mechanical Engineering
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Global Academy of Technology – An Overview

(Autonomous Institution under Visvesvaraya Technological University, Belagavi)

Vision of the Institute:

Become a premier institution imparting quality education in engineering and management to meet the changing needs of society.

***Mission of the Institute*:**

- **Create environment conducive for continuous learning through quality teaching and learning processes supported by modern infrastructure.**
- **Promote Research and Innovation through collaboration with industries.**
- **Inculcate ethical values and environmental consciousness through holistic education programs.**

Objectives:

With a very firm resolve, Global Academy of Technology is continuously investing untiring efforts to enable students to:

- Develop careers in Government and Private engineering organizations and other professionally related domains.
- Pursue higher studies and research to develop innovative solutions and technologies in engineering and other multi-disciplinary areas.
- Improve professional and personal traits oriented towards professional ethics and environmental compulsions.
- Inculcate professional leadership and successful entrepreneurship qualities.
- Help society in raising the quality of life.

Quality Policies:

a. Providing Excellent Education Through High Quality, Experienced and Committed Faculty.
b. Evolving creative processes for optimal Knowledge and Skill Transfer.
c. Building up state-of-the-art infrastructure at par with international standards.
d. Creating an environment for holistic personality development and develop research temperament.

HALLMARKS OF GLOBAL ACADEMY OF TECHNOLOGY:

- Proactive management determined to build the institute as a Centre of Excellence in engineering education.
- Qualified and dedicated faculty in all the departments.
- State of the art Infrastructure and up to date laboratory and Library facilities.
- Lush green campus with an environment of tranquillity and harmony.
- Student centric teaching-learning processes banking on Outcome Based Education; students friendly learning atmosphere.
- Emphasis on Project based learning throughout the course.

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- Strong Industry-Institute interface with more than twenty Memorandum of Understanding (MOUs) signed with leading industries and institutions of repute.
- Indian Institute of Information Technology (IIIT), Allahabad, has signed a MOU for providing internships to students of GAT, research assistance to faculty, and conducting Faculty Development Programs in key areas of IT - Big Data, Cloud Computing, Artificial Intelligence, and Machine Learning.
- Mahatma Gandhi University, Kottayam, has signed a MOU to facilitate research in Nano Technology and provide research assistance to faculty of GAT.
- Industrial consultancy undertaken in many departments.
- Excellent Placement with more than 80% of the eligible students placed in leading IT companies, core industries and Start-up companies.
- Holistic and integrated training modules covering communication skills, leadership skills, soft skills and technical skills through professional trainers.
- On campus and off campus internship facilities.
- Robust parent connects and Student counselling system.
- In-house technical skill training programs/add on courses to enhance the employability of the students.
- Strong and growing alumni connect in place.
- Exclusive Research and Development, Industry–Institute Interaction Cell and Teaching and Learning Centre in place.
- Rainwater harvesting facility in the campus.

The following academic processes are implemented on a regular basis to sustain a meaningful and proactive teaching-learning environment:

- Emphasis on **continuous revision of the curriculum,** based on feedback from the students and input from industry, alumni, and other stakeholders.
- Conduction of regular **training programme** for faculty, technical & supporting staff.
- Conduction of Academic Audit of each department on an annual basis.
- Under **open electives** students have the options to study subjects offered by other departments to augment their interdisciplinary knowledge.
- Students have to do **value added courses**, mandatory courses, certificate courses, and become members of professional bodies, etc.
- Advanced and enrichment courses are offered as Electives during the final year UG and PG Degree Programmes.
- **Self-Learning** is encouraged in students through MOOCs, NPTEL/SWAYAM, Coursera, Edex etc. Credit shall be awarded to students for completion of such courses.

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Department of Mechanical Engineering

(Accredited by National Board of Accreditation, New Delhi)

Vision of the Department:

Become one of the leading providers of education in mechanical engineering with emphasis on research, development, and innovation for the benefit of society.

Mission of the Department:

- Impart quality technical education in the field of mechanical engineering through excellent teaching-learning process, modern infrastructure and computing tools
- Prepare students for successful careers by providing placements and encouraging research, development and innovation through industry-institute interaction
- Instil professional ethics and environmental consciousness amongst students through inclusive development programs

About the Department:

Mechanical Engineering is one of the broadest and the most versatile engineering profession finding its application in all fields of technology. The boost in the manufacturing sector has raised the demand for Mechanical Engineers exponentially. The uniqueness of the discipline incorporates skills and expertise in the areas of Design, Manufacturing, Mechanics and Thermal sciences besides inter-disciplinary subjects that are essential to most sectors of industry.

The department is achieving its milestones at various stages of its growth by upgrading the course-curriculum for catering the needs of industry and research, by developing and maintaining state-of-art laboratories CNC Technology, 3D Printing and Automation.

The department conducts various training programs in collaboration with renowned industrial organizations such as Toyota, AMS-India, TATA Electronics Pvt. Ltd, EMI Product, Askar Microns, etc.

Our student teams have developed Formula Car, Go Kart and Solar Powered Vehicle and participated in racing competitions, won prizes, and have brought laurels to our department and to the college.

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022-23)

III SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT31C	Complex Variables and Probability	BS	MAT	2	2	0	50	50	100	3
2	22MED32	Strength of Materials (Integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	22MED33	Manufacturing Process (Integrated)	IPC		3	0	2	50	50	100	4
4	22MED34	Computer Aided Modelling	PC		2	0	2	50	50	100	3
5	22MED35	Material Science and Engineering	ESC		3	0	0	50	50	100	3
6	22MED36	Ability Enhancement Course – I: **Modelling & 3D Printing**	AEC		2	0	2	50	50	100	3
							Total	**300**	**300**	**600**	**20**

IV SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT41C	Transforms Calculus and Numerical Techniques	BS	MAT	2	2	0	50	50	100	3
2	22MED42	Mechanical Measurements & Metrology (Integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	22MED43	Mechatronics	PC		3	0	0	50	50	100	3
4	22MED44	Theory of Machines	PC		2	2	0	50	50	100	3
5	22MED45	Thermodynamics	ESC		2	2	0	50	50	100	3
6	22MED46	Ability Enhancement Course – II: **Automation through Hydraulics & Pneumatics**	AEC		2	0	2	50	50	100	3
7	22MEDL47	Machine Shop	PC		0	0	1	50	50	100	1
							Total	**350**	**350**	**700**	**20**

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

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(Effective from the academic year 2023-24)

V SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	HSMS	22MED51	Industrial Management & Economics	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	IPCC	22MED52	Fluid Mechanics Machinery	TD:ME PSB:ME	2	2	2		03	50	50	100	4
3	PCC	22MED53	Machine Design	TD: ME PSB:ME	3	2	0		03	50	50	100	4
4	PCCL	22MEDL54	CNC Programming Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
5	PEC	22MED55x	Professional Elective - I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
6	PROJ	22MEDP56	Mini Project	TD: ME PSB:ME	0	0	4		03	100	-	100	2
7	AEC	22RMIK57	Research Methodology and IPR	Any Department	3	0	0		03	50	50	100	3
8	MC	22CIVK58	Environmental Studies	TD: CV/Env/Chem PSB:CV	2	0	0		02	50	50	100	2
9	MC	22NSK59	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		22PEK59	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YOK59	Yoga	Yoga Teacher									
									Total	550	350	900	22

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Professional Elective Course - I			
22MED55A	Mechanical Vibrations	22MED55C	Supply Chain Management & Introduction to SAP
22MED55B	Product Life Cycle Management	22MED55D	Automation in Manufacturing

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K** : The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course.

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batchmates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

VI SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED61	Finite Element Methods	TD: ME PSB:ME	2	2	0		03	50	50	100	3
2	IPCC	22MED62	Heat Transfer	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PEC	22MED63x	Professional Elective - II	TD: ME PSB:ME	3	0	0		03	50	50	100	3
4	OEC	22MED64x	Open Elective -I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	PROJ	22MEDP65	Major Project Phase - I	TD: ME PSB:ME	0	0	4		03	100	-	100	2
6	PCCL	22MEDL66	Analysis Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	AEC/ SDC	22MED67x	Ability Enhancement Course/ SkillDevelopment Course - III	TD & PSB: Concerned Department	If the course is offered as a Theory: 2	0	0		01	50	50	100	2
					If course is offered as a practical: 1	0	2						
8	MC	22UHK68	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	- - -	100	0
		22PEK68	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YOK68	Yoga	Yoga Teacher									
9	IKS	22IKSK69	Indian Knowledge System	Any Department	1	0	0		01	50	50	100	0
10	MC	22UHV69	Universal Human Values	Any Department	1	0	0		01	50	50	100	0
									Total	**600**	**400**	**1000**	**18**

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Professional Elective Course- II			
22MED63A	Design of Transmission Elements	22MED63C	Project and Operations Management
22MED63B	Refrigeration and Air Conditioning	22MED63D	Renewable Energy Technologies
Open Elective Course - I			
22MED64A	Supply Chain Management & Introduction to SAP	22MED64C	Total Quality Management
22MED64B	Operations Research	22MED64D	Modern Mobility
Ability Enhancement Course / Skill Enhancement Course - III			
22MED67A	Basics of MATLAB	22MED67C	Introduction Augmented Reality
22MED67B	Fundamental of Virtual Reality ARP Development	22MED67D	Simulation and Analysis using Ansys workbench

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K** : The letter in the course code indicates common to all the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics) and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme A- VII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED71	Industrial Robotics	ME, PSB:ME	3	0	0		03	50	50	100	3
2	PCC	22MED72	Operations Research	ME, PSB:ME	3	0	0		03	50	50	100	3
3	PCC	22MED73	Control Engineering	ME, PSB:ME	3	2	0		03	50	50	100	4
4	PEC	22MED74x	**Professional Elective-III**	ME PSB:ME	3	0	0		03	50	50	100	3
5	OEC	22MED75x	**Open Elective- II**	ME PSB:ME	3	0	0		01	50	50	100	3
6	PROJ	22MEDP76	**Major Project Phase-II**		0	0	12		03	100	100	200	6
7	PCCL	22MEDL77	Design Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
8	PCCL	22MEDL78	Energy Engineering Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
									Total	**450**	**450**	**900**	**24**

Professional Elective - III

22MED74A	Design for Manufacturing and Assembly	22MED74C	Total Quality Management
22MED74B	Thermal Management of Electronic Equipment	22MED74D	Automotive Engineering & Hybrid Vehicle Technology

Open Elective - II

22MED75A	Additive Manufacturing	22MED75C	Renewable Energy Power plants
22MED75B	Project and Operations Management	MED23705D	Strategies for Sustainable Design

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD**- Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **FEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI

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semester.

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK (21MEP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students tc present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve ingroup discussion to present anc exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the Department concerned and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme A- VIIISEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	22MED81x	Professional Elective - IV (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	OEC	22MED82x	Open Elective - III (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
3	INT	22MEDI83	Internship (Industry/Research) (14 - 20 weeks)	TD: ME	0	0	12		03	100	100	200	10
									Total	**200**	**200**	**400**	**16**

Professional Elective - IV (Online courses)

22MED81A	Quality Design & Control (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_mg24/preview	22MED81C	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc22_me60/preview
22MED81B	Product Design and Manufacturing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_me66/preview	22MED81D	Computer Integrated Manufacturing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc22_me10/preview

Open Elective - III (Online Courses)

22MED82A	Fundamentals of automotive systems (Available in NPTEL) https://archive.nptel.ac.in/courses/107/106/107106088/	22MED82C	Strategies for Sustainable Design (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_de07/preview
22MED82B	Industrial Safety Engineering (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc20_mg43/preview	22MED82D	Business Planning & Project Management (Available in NPTEL) https://onlinecourses.swayam2.ac.in/cec21_ge06/preview

L: Lecture, **T:** Tutorial, **P:** Practical **S= SDA:** Skill Develcpment Activity, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation. **TD-** Teaching Department, **PSB:** Paper Setting department, **OEC:** Open Elective Course, **PEC:** Professional Elective Course. **PROJ:** Project work, **INT:** Industry Internship / Research Internship / Rural Internship

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Note: VII and VIII semesters of IV years of the program

Swapping Facility

- Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ Industry internships/Rural Internship** after the VI semester.
- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, centre of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **University shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the VTU web portal.

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme B-VI SEMESTER for the candidates who seek a two-semester internship with project work /Start-up

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED61	Finite Element Methods	TD: ME PSB:ME	3	0	2		03	50	50	100	3
2	IPCC	22MED62	Heat Transfer	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PEC	22MED63X	Professional Elective - II	TD: ME PSB: ME	4	0	0		03	50	50	100	3
4	OEC	22MED64X	Open Elective - 1	TD: ME PSB: ME	3	0	0		03	50	50	100	3
5	PCCL	22MEDL66	Analysis Laboratory	TD: ME PSB: ME	3	0	0		01	50	50	100	1
6	AEC	22MED67X	Ability Enhancement Course/Skill Development Course III	TD: ME PSB:ME	If the course is offered as a Theory: 2	0	0		03	50	50	100	2
					If course is offered as a practical: 1	0	2						
7	MC	NSK2268	National Service Scheme (NSS)	NSS coordinator	0	0	2		03	100	-	100	0
		PEK2268	Physical Education (PE) (Sports and Athletics)	Physical Education Director					03				
		YOK2268	Yoga	Yoga Teacher					01				
8	IKS	IKSK2269	Indian Knowledge System	Any Department	0	0	12		03	100	0	100	0
									Total	500	300	800	16

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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme B: VII and VIII semesters for the candidates who seek an internship with project work

Sl. No	Course and Course Code		Course Title	Teaching Department (TD)and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration inhours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED71	Industrial Robotics To be completed in 5th/6th semester	TD: ME PSB:ME	3	0	2		03	50	50	100	3
2	PCC	22MED72	Hydraulics and Pneumatics To be completed in 5th /6th semester	TD: ME PSB:ME	3	0	2		03	50	50	100	3
3	PCC	22MED73	Control Engineering To be completed in the 6th semester	TD: ME PSB: ME	4	0	0		03	50	50	100	3
4	PEC	22MED74x	Professional Elective Course (MOOC Courses)	TD: ME PSB: ME	3	0	0		03	50	50	100	3
5	OEC	22MED75x	Open Elective Courses (MOOC courses)	TD: ME PSB: ME	3	0	0		01	50	50	100	3
6	PCCL	22MED77	Design Laboratory To be completed in 5th /6th semester	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	PCCL	22MED78	Energy Engineering Laboratory To be completed in 5th /6th semester	TD: ME PSB:ME	0	0	2		03	50	50	100	1
1	PEC	22MED81x	Professional Elective -IV (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	OEC	22MED82x	Open Elective - III (Online Courses)	TD: ME PSB:ME	3	0	0		01	50	50	100	3
3	PROJ	22MED83	Project – Outcome of Training	TD: ME PSB:ME	0	0	12		03	100	100	200	9
4	INT	22MED84	Internship (Industry/Research) (02 semesters)	TD: ME	0	0	12		03	100	100	200	10
									Total	**650**	**650**	**1300**	**42**

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III - IV SEMESTER
SCHEME AND SYLLABUS
Department of
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Scheme of UG Autonomous Program – 2022 Batch

III SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT31C	Complex Variables and Probability	BS	MAT	2	2	0	50	50	100	3
2	22MED32	Strength of Materials (Integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	22MED33	Manufacturing Process (Integrated)	IPC		3	0	2	50	50	100	4
4	22MED34	Computer Aided Modelling	PC		2	0	2	50	50	100	3
5	22MED35	Material Science and Engineering	ESC		3	0	0	50	50	100	3
6	22MED36	Ability Enhancement Course – I: **Modelling & 3D Printing**	AEC		2	0	2	50	50	100	3
							Total	**300**	**300**	**600**	**20**

IV SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT41C	Transforms Calculus and Numerical Techniques	BS	MAT	2	2	0	50	50	100	3
2	22MED42	Mechanical Measurements & Metrology (Integrated)	IPC	Respective Department	3	0	2	50	50	100	4
3	22MED43	Mechatronics	PC		3	0	0	50	50	100	3
4	22MED44	Theory of Machines	PC		2	2	0	50	50	100	3
5	22MED45	Thermodynamics	ESC		2	2	0	50	50	100	3
6	22MED46	Ability Enhancement Course – II: **Automation through Hydraulics & Pneumatics**	AEC		2	0	2	50	50	100	3
7	21MEDL47	Machine Shop	PC		0	0	1	50	50	100	1
							Total	**350**	**350**	**700**	**20**

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III SEMESTER

SYLLABUS

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SEMESTER – III

Course: Complex Variables and Probability

Course Code	**22MAT31C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of mathematics in the field of engineering by making them to learn:

CLO1	Analytic functions and complex line integrals
CLO2	Probability distributions
CLO3	Joint probability distributions
CLO4	Sampling distributions and testing of hypothesis

	No. of Hours/ RBT levels
Module 1 Function of a complex variable, Analytic functions, Cauchy-Riemann equations, construction of analytic functions using Milne Thomson method, Properties of analytic functions.	**08 Hours L2, L3**
Module 2 Conformal mapping, Bilinear transformations. Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Singularities, poles, residues, Cauchy's residue theorem.	**08 Hours L2, L3**
Module 3 Probability, Axioms of probability, Conditional probability, Bayes theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Uniform, Poisson, Exponential, Normal distributions.	**08 Hours L2, L3**
Module 4 Joint distributions (both discrete and continuous), Marginal and conditional distributions, Expectation and Covariance. Transformation of random variables, Central limit theorem and law of large numbers.	**08 Hours L2, L3**
Module 5 Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, student's t-distribution, chi-square distribution as a test of goodness of fit.	**08 Hours L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO31.1	Apply Cauchy Riemann equations to study different properties of analytic functions
CO31.2	Evaluate complex line integrals
CO31.3	Solve problems associated with random variables using probability distributions
CO31.4	Solve problems related to testing of hypothesis

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Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. T Veerarajan, Probability, Statistics and Random Processes for Engineers, Tata McGraw Hill, 3rd Edition, 2008

Reference books:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6 th Edition, 2014
3. Richard H Williams, Probability, Statistics and Random Processes for Engineers, Cengage Learning, 1st Edition, 2003.

Scheme of Examination:

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO31.1	3	2	1									3				
CO31.2	3	2	1									3				
CO31.3	3	2	1									3				
CO31.4	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

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SEMESTER – III

Course: STRENGTH OF MATERIALS (Integrated)

Course Code	22MED32	CIE Marks (Theory + Lab)	30 + 20 = 50
Hours/Week (L: T: P)	3 : 0 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Identify different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
CLO2	To Solve problems on Elastic constants and determine Principal stresses for Uniaxial and Biaxial loads.
CLO3	Concept of Shear Force and Bending Moment Diagrams for beams subjected to different types of loads.
CLO4	Determine the maximum bending and shear stress in a given beam.
CLO5	Apply torsion equation to calculate angle of twist, size of shafts & shear stresses

Content	No. of Hours/ RBT levels
Module 1 **Simple stresses and strains:** Introduction, Properties of materials, Stress, Strain, tensile & compressive stresses, shear stress, Elastic limit, Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Bars of varying sections, bars with cross sections varying in steps, bars with continuously varying cross sections (Circular & rectangular only) **Laboratory:** *Laboratory Exercise – 1, 2*	**08 Hours / L3**
Module 2 Thermal stresses, Shear stress and shear strain, Longitudinal strain, Lateral strain, Poisson's ratio, Volumetric strain, Elastic constants, and their relations. **Principal stresses and Mohr's Circle:** Introduction to uniaxial, bi-axial, bi-axial combined with shear stress, Stresses on inclined planes, Principal stresses and maximum shear stresses, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Thick and thin Cylinders**: Theoretical concepts only. (No Numerical) **Laboratory:** *Laboratory Exercise – 3*	**08 Hours / L3**
Module 3 **Shear Force & Bending moment diagram:** Introduction, types of beams, loads & reactions, shear force & bending moment. Sign convention for shear force and bending moment, Shear force and bending moment diagram for simply supported, cantilever & overhanging beams subjected to concentrated loads, uniformly distributed load, uniformly varying load & external moment. Maximum bending moment & point of contra flexure. **Laboratory:** *Laboratory Exercise – 4*	**08 Hours / L3**

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Module 4 **Bending stress in beams:** Introduction, theory of Pure or Simple bending, assumptions in pure bending, bending equation, Bending stress, Section modulus for various cross sections and simple numerical. **Shear stresses in beams:** Introduction to shear stress, shear stress in beam, Shear stress distribution for rectangular and circular cross section, simple numerical on shear stress on I and T sections. **Laboratory:** *Laboratory Exercise – 4, 6*	**08 Hours / L3**
Module 5 **Torsion of circular shafts:** Introduction, pure torsion, assumptions, Derivation of shear stress produced in solid and hollow circular shafts subjected to torsion, polar moment of Inertia, polar section modulus, torsional rigidity, power transmitted by a shaft. Simple numericals. **Deflection of Beams:** Introduction, differential equation for deflection, equations for deflections, slope and moments. **Laboratory:** *Laboratory Exercise – 5, 7*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO32.1	**Analyze** the fundamental concepts of stress, strain, deformation, and material behavior under various loading conditions.
CO32.2	**Evaluate** thermal stresses, elastic constants, and biaxial stresses in conjunction with shear stress in structural materials.
CO32.3	**Design** statically determinate beams, creating detailed shear force and bending moment diagrams for beams subjected to different loading scenarios.
CO32.4	**Assess** bending and shear stresses in statically determinate beams with varying cross-sectional profiles and apply these concepts to structural analysis.
CO32.5	**Apply** advanced principles of torsion and deflection to critically analyze the mechanical behavior of shafts and beams under various loading conditions.

Laboratory:

Exercise Number	Experiment	No. of Hours/ RBT Levels
1	Brinell, Rockwell and Vickers's hardness tests	**01 Hours/ L3**
2	Tensile and Compression tests of metallic members on UTM	**04 Hours/ L3**
3	Shear tests of metallic members on UTM	**02 Hours/ L3**
4	Bending test on metallic and non-metallic specimens on UTM	**01 Hours / L3**
5	Torsion test	**01 Hours / L3**
6	Izod and Charpy impact tests on MS Specimen. (Demo only)	**01 Hours / L3**
7	Wear characteristics. (Demo only)	

Textbooks:

1. **James M Gere, Barry J Goodno**, Mechanics of Materials, 9th Edition, Cengage, 2019.
2. **Ferdinand Beer & Russell Johnston**, Mechanics of materials, S.I units, TATA McGrawHill – 1st edition 2003
3. **Timoshenko**, Strength of Materials, 3rd Edition, CBS Publishers, 2002.

Reference books:

1. **William A Nash and Merle C Potter**, Strength of Materials, Schaum's Outline Series, 5th Edition, TMH.
2. **R C Hibbeler**, Mechanics of Materials, 9th Edition, Pearson, 2019.

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3. **Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, David F. Mazurek, Sanjeev Sanghi**, Mechanics of Materials by 8th Edition, Special Indian Edition, 2020.
4. **S Ramamrutham & R Narayanana**, Strength of Materials, Dhanat Rai Publishing Company, 18th Edition, 2016.

E-Books / Web References

1. **E - Books:** "Strength of Materials", (http://freeengineeringbooks.com/Civil/Strength-of-Material-Books.php)
2. https://ocw.tudelft.nl/courses/aerospace-mechanics-of-materials/mechanics-subjects/
3. https://www.youtube.com/watch?v=_DH3546mSCM

MOOCs

1. NPTEL Course: "Strength of Materials" http:// https://nptel.ac.in/courses/112/107/112107146/#
2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Mechanics of Materials Courses", (https://www.coursera.org/courses?query=mechanics%20of%20materials)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO32.1	3	2	2	-	-	1	1	-	1	1	-	1	2		
CO32.2	3	2	2	-	-	1	1	-	1	1	-	1	2		
CO32.3	3	2	2	-	-	1	1	-	1	1	-	1	2		
CO32.4	3	2	2	-	-	1	1	-	1	1	-	1	2		
CO32.5	3	2	2	-	-	1	1	-	1	1	-	1	2		
Average	3	2	2	-	-	1	1	-	1	1	-	1	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: MANUFACTURING PROCESS (Integrated)

Course Code	22MED33	CIE Marks (Theory + Lab)	30 + 20 = 50
Hours/Week (L: T: P)	3 : 0 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives: This course will enable the students to,

CLO1	Understand the various manufacturing processes and their methods involved in metal casting and process of moulding sands.
CLO2	Understand metal joining process, identify defects in weld, and cast components.
CLO3	Acquire knowledge of the working principles and operations performed on lathe, drilling, shaping, milling and grinding machines.
CLO4	Acquire knowledge of the working principles and operations performed on milling and metal finishing process.
CLO5	Acquire knowledge on principles and types of metal forming with specific regard to industrial applications.

Content	No. of Hours/ RBT levels
Module 1 **Pattern & Pattern Making:** Introduction to manufacturing, classification of manufacturing processes, introduction to foundry - Steps involved in casting, advantages, limitations, and applications of casting process. Pattern types, pattern materials, color coding and storing of patterns, allowances for pattern. **Moulding:** Moulding sand composition, preparation, properties, Binders, Additives. Moulding methods: No bake mould, sweep mould, CO_2 mould, shell mould, investment mould. Introduction to Melting furnaces, Direct and Indirect Furnace, Electric Arc Furnace, Cupola furnace. **Demonstration:** *Properties of Moulding Sand - Sand Testing* **Laboratory:** *Laboratory Exercise – I, II*	**08 Hours / L3**
Module 2 **Welding Process:** Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW), Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. **Defects & Inspection:** Sand Casting defects, welding defects- detection causes & remedy, Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection. **Laboratory:** *Laboratory Exercise – III and IV*	**08 Hours / L3**

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Module 3 **Lathe:** Types of lathes, parts of engine lathe, Operations and accessories of lathe machine: Centres, Chuck, Faceplate, Mandrel, Steady rest, follower rest, lathe dog, cutting speed, feed, and depth of cut. Machining time and power consumption. **Drilling:** Working principle, the nomenclature of twist drill, Classification, radial drilling machine. Machining time and power consumption.	**08 Hours / L3**
Module 4 **Milling:** Principle of milling, types of milling machines, Horizontal and Vertical milling machine with a sketch, milling machine speeds, and feeds, Milling cutters, Indexing: Simple, compound, differential indexing with simple numerical. Machining time and power consumption. **Metal Finishing Processes:** Introduction to grinding, Plain Cylindrical, Surface, Centreless grinding machines. Surface finish and surface roughness, Introduction to lapping, Honing, Polishing, Buffing.	**08 Hours / L3**
Module 5 **Metal Forming Process** Introduction to metal forming processes & classification of metal forming processes, Hot working and cold working of metals, Forging: Smith forging, drop forging & press forging, rolling of metals, Flat strip rolling, shape rolling operations. Principle of rod and wire drawing, Tube drawing, Principles of Extrusion, Hot and Cold extrusion. **Laboratory:** *Laboratory Exercise – V and VI*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO33.1	**Design** mold cavities using patterns made from wood, metal, and plastics, effectively applying pattern allowances to ensure precise casting outcomes.
CO33.2	**Select** the appropriate arc welding process for specific applications and analyze the common defects arising from casting and welding processes to propose corrective measures.
CO33.3	**Evaluate** the operational principles of lathe, drilling, and shaping machines, and their effective use in practical machining applications.
CO33.4	**Assess** and optimize milling and metal finishing operations by applying advanced techniques to improve surface quality and production efficiency.
CO33.5	**Integrate** metal forming processes into real-world manufacturing applications, analyzing process parameters to enhance product quality and production efficiency.

Laboratory:

Exercise Number	Experiment	No. of Hours/RBT Levels
I & II	Preparation of Green Sand Mould - Single Piece Pattern and Split Piece Pattern and Development of a Cast product.	04 Hours/ L3
III & IV	Preparation of Welding Joints (At least two)	02 Hours/ L3
V & VI	Preparation of Forged Models (At least two)	04 Hours/ L3

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Textbooks:

1. **P. N. Rao,** Manufacturing Technology Foundry, Forming & Welding, Volume-I, McGraw Hill Education India, 4th Edition, 2019.
2. **O.P. Khanna,** Volume I and II, Dhanpat Rai Publications, 2017.

Reference books:

1. **Lindberg,** Processes and Materials of Manufacture, Prentice Hall India (p) Ltd
2. **Dr. P.C. Sharma,** A Textbook of Production Technology, S.Chand & Company PVT.LTD, 4th Edition, 2014.
3. **Amitabha Ghosh, Ashok Kumar Malik,** Manufacturing Science, Affiliated East-West Press Ltd, 1st Edition, 2015.
4. **Hajra Choudhary,** Workshop Technology, Media Promoters & Publishers, 13th Edition.
5. **Kalpakjian S., Schmid S.R,** Manufacturing Engineering & Technology, Pearson Edu Asia, 4th Edition.

E-Books / Web References

1. Metal casting- https://nptel.ac.in/courses/112107083/
2. Manufacturing process I - https://nptel.ac.in/courses/112107145/17
3. Manufacturing Process (video) - http://nptel.ac.in/courses/112107145/
4. Manufacturing Process- http://freevideolectures.com
5. Introduction to Casting- https://nptel.ac.in/courses/112107083/
6. Types of Furnaces- https://nptel.ac.in/courses/112107239/16
7. Introduction to Metal Forming - https://nptel.ac.in/courses/112107145/4
8. Plastic properties and Processing- https://nptel.ac.in/courses/112107086/13

MOOCs

1. https://nptel.ac.in/courses/112/104/112104301/
2. https://nptel.ac.in/courses/112/104/112104195/
3. https://www.youtube.com/watch?v=jdFrBtHeJbs&list=PLtAjRFb9nXmzRwSuuYmUoIxIQOu5ccdM
4. https://nptel.ac.in/courses/112/104/112104204/
5. https://nptel.ac.in/courses/112/104/112104195/
6. E-learning: www.vtu.ac.in

Scheme of Examination: (Integrated courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):

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Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO33.1	3	2	1						1	1		1			3
CO33.2	3	2	1						1	1		1			3
CO33.3	3	2	1						1	1		1			3
CO33.4	3	2	1						1	1		1			3
CO33.5	3	2	1						1	1		1			3
Average	3	2	1						1	1		1			3

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: COMPUTER AIDED MODELLING

Course Code	22MED34	CIE Marks	50
Hours/Week (L: T: P)	2 : 0 : 2	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Computer Aided Engineering Drawing.

Course Objectives: This course will enable the students to

CLO1	Understand orthographic projection principles, create detailed drawings with dimensions and annotations.
CLO2	Draw the 3D part Model from the 2D sketches using Fusion 360.
CLO3	Develop Part Models and create assembly using Fusion 360.
CLO4	Convert Assembly drawing into 2D drafting and generate Bill of materials for Part/ subassembly/ assembled drawing.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Fusion 360 Software:** 3D Sketching Overview. **3D Models/Assembled Models:** Introduction to orthographic projection, Principle of visualization of objects, creating detailed drawings of simple machine elements in first angle projection for the provided 3D models/Assembled models, dimensions, Annotations, sectional views, full and half-sectional views, Bill of Materials. Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Geometrical tolerances on drawings, Standards followed in the industry.	**10 Hours / L1, L2, L3**
Module 2 **Introduction to part drawing:** Conversion of 2D drawings into 3D parts and sectional views of simple machine components (Detailed 2D part drawings will be given).	**10 Hours / L1, L2, L3**
Module 3 **Introduction to assembly drawing:** Assembly of simple machine elements like Screw Jack, Machine Vice, Plummer block, Tool post, Socket and spigot Joint, Protected type flanged Coupling, (Detailed 2D part drawings will be given).	**15 Hours / L1, L2, L3**
Module 4 **Assembly Dataset:** Assembly of simple machine elements using dataset provided. **The Explode-Render application:** Exploding an assembly. **Rendering -** define textures, lighting, shadows, backgrounds and other properties to create presentation style images. Assign material properties to parts and subassemblies.	**5 Hours / L1, L2, L3**

Additional Assembly drawing for Practice purpose only: Tail stock, Rams bottom safety valve, windmill, Pelton Wheel, Kaplan Turbine, Francis Turbine, Bicycle, Car Body, PUMA 6-Axis Robot.

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO34.1	Demonstrate skills in utilizing Fusion 360 for developing a detailed orthographic view from 3D models with precise dimensioning, and annotations.
CO34.2	Create 3D representations from detailed 2D part drawings
CO34.3	Create assembly drawings based on provided engineering drawings, showcasing proficiency in assembling and illustrating complex components within the given design context.
CO34.4	Develop a 3D geometric model of machine assemblies using datasets, followed by the conversion of these models into 2D drafting.

Textbooks:

1. **K R Gopalakrishna,** Machine Drawing, New Age International Publishers, 6th Edition, 2019.
2. **N. D. Bhatt,** Machine Drawing, Charotar Publication, 50th Edition 2016.

Reference books:

1. **KL Narayana, P Kannaiah, K V Reddy,** Machine Drawing, New Age International Publishers, 6th Edition, 2019.
2. **Sidheshwar,** Machine Drawing, Tata McGraw-Hill Education, 33 reprint 2006.
3. **R. K. Dhawan,** Machine Drawing, S Chand Publishing reprint, 2006.

E-Books / Web References

1. https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
2. Introduction to Modelling and Design for Manufacturing
3. https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design professional

Scheme of Examination: Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be Four full questions. First, Second & fourth module carrying 20 marks each and third module carrying 40 marks. Students are required to answer **any Four full questions choosing at least one full question from each module.**

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. Average of three test is considered and added to assignment component of 10 marks.

Some possible AATs: Assignments/ oral presentation/ group activity / projects /any other. Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO34.1	1	2	1		3			1	1	3		1	2		
CO34.2	1	2	1		3			1	1	3		1	2		
CO34.3	1	2	1		3			1	1	3		1	2		
CO34.4	1	2	1		3			1	1	3		1	2		
Average	1	2	1		3			1	**1**	3		1	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – III

Course: MATERIAL SCIENCE AND ENGINEERING

Course Code	22MED35	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives: To enable students to apply the knowledge of materials and alloys by making them learn the:

CLO1	Basics of crystal structure and mechanism of nucleation in solids.
CLO2	Cooling curves and transformation diagrams of metals and alloys.
CLO3	Principles and varied methods of het treatment and its emphasis on structure property correlation of metals and alloys.
CLO4	Deformation and fracture mechanisms in metals and alloys.
CLO5	Trends in material technology with focus on nanomaterials, composites.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Crystal Structure:** Introduction, crystal structures, packing factor of cubic and HCP, structure, coordination number, Simple numerical on FCC, BCC crystal structure, crystal imperfections point, & line defects, Diffusion, Diffusion Mechanisms, Fick's laws of diffusion. **Homogeneous and heterogeneous nucleation**: Mechanism of solidification – nucleation and crystal growth, dendritic growth. Phases-single phase and multiphase solids, Gibb's phase rule, solid solutions and types, Intermediate phases, Types of phase diagrams.	**08 Hours / L1, L2, L3**
Module 2 **Cooling Curves and TTT Diagrams** Cooling curve for pure iron, Fe-C equilibrium diagrams, study of iron-carbon system in detail with emphasis on the invariant reactions **TTT Diagrams**: Introduction to TTT, Drawing of TTT diagram for Steels.	**08 Hours / L1, L2, L3**
Module 3 **Heat treatment Processes** Annealing, Normalizing, Hardening, Tempering, Mar tempering, Austempering, Concept of hardenability, Jominyend quench test, Factors affecting hardenability. **Surface hardening methods:** carburizing, cyaniding, nitriding, flame hardening and induction hardening.	**08 Hours / L1, L2, L3**
Module 4 **Mechanical Metallurgy**: Plastic deformation, slip and twinning. Fracture: types, stages	**08 Hours / L1, L2, L3**

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in cup & cone fracture, Griffith's criterion. **Fatigue and creep:** fatigue tests, mechanism, S-N curves, Factors affecting fatigue life. Various stages of creep, Mechanisms of creep, effect of temperature, creep fracture.	
Module 5 **Engineering Alloys**: Steel: Method of designation as per AISI–SAE. Properties, composition, and uses of low, medium, and high carbon steels. **Cast irons**: Microstructures & properties of White CI, Grey CI. Aluminum alloys, Copper alloys and introduction to metallography. **Introduction to plastic, ceramics, and Composite materials:** Classification of composites- Engineering applications of different plastics, ceramics & Composite Materials.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO35.1	Analyze the fundamental concepts of bonds & crystal structures during deformation of materials
CO35.2	Infer cooling curves and its correlation to structure and property in ferrous materials
CO35.3	Interpret the varied heat treatment process and its suitability to achieve desired mechanical properties.
CO35.4	Explore the creep, fatigue, and fracture behaviour of materials.
CO35.5	Categorize the material properties with developments of latest materials

Textbooks:

1. **Smith, Mc Graw Hill,4thEdition, 2009.**Foundations of Materials Science and Engineering
2. **William D. Callister, Wiley,** 2006 Material science and Engineering and Introduction
3. **Shackle ford., & M. K. Muralidhara,** Materials Science, Pearson Publication, 2007

Reference books:

1. **V.Raghavan**, Materials Science and Engineering, PHI, 2002
2. **Donald R. Askland and Pradeep .P. Phule**, The Science and Engineering of Materials, Cengage Learning 4lhEd., 2003

E-Books / Web References

1. **V Raghavan,** Materials science and Engineering by PHI,6th Edition,2016
   http://jp.b-ok.as/ireader/3384942

MOOCs

1. http:// onlinecourses.nptel.ac.in/noc19_me70/preview
2. http://nptel.ac.in/courses/112/106/112106138/

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

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Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three test is taken, CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz/AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO35.1	3	2	1	1		1	1					1			1
CO35.2	3	2	1	1		1	1					1			1
CO35.3	3	2	1	1		1	1					1			1
CO35.4	3	2	1	1		1	2					1			1
CO35.5	3	2	1	1		1	2					1			1
Average	**3**	**2**	**1**	**1**		**1**	**2**					**1**			1

Low - 1: Medium - 2: High – 3

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SEMESTER – III
Course: Ability Enhancement Course – I

Modelling & 3D Printing

Course Code	22MED36	CIE Marks	50
Hours/Week (L: T: P)	2: 0 : 2	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to:

CLO1	Grasp the fundamental concepts behind additive manufacturing, including the various technologies, materials, and processes
CLO2	Acquire knowledge and skills in Computer-Aided Design (CAD) software, enabling the creation and optimization of 3D models through slicing
CLO3	Learn post-printing procedures such as removing supports, surface finishing, and quality inspection to refine and enhance the final printed objects
CLO4	Learn how to set up, calibrate, and troubleshoot these machines for efficient and accurate printing

Content	No. of Hours/ RBT levels
Module 1 Introduction: Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications	**05 Hours / L3**
Module 2 Additive Manufacturing Techniques: Fusion Deposition Modelling, Stereolithography, Selective Laser Sintering, Selective Laser Melting	**05 Hours / L3**
Module 3 Polymer Materials for FDM process: Acrylonitrile Butadiene Styrene (ABS), Polylactic Acid (PLA), Polyethylene Terephthalate Glycol (PETG), Thermoplastic polyurethane (TPU).	**05 Hours / L3**
Module 4 Post Processing: Significance of post-processing in additive manufacturing, Challenges and methods of post processing	**05 Hours / L3**

Practical Sessions	No. of Hours/ RBT levels
Computer Aided Design: Development of 3D Models, STL file generation *Tools used:* Tinker CAD and Autodesk Fusion 360	**05 Hours / L4**
Slicing: STL file manipulation, Object positioning and placement, Slicing parameters: Layer height, print speed, support settings, temperature settings, Generation of G- and M-codes. *Tools used*: Repetier host	**05 Hours / L5**
Printing: Machine setup, Build	**05 Hours / L5**
Post processing: Removal and clean-up, Finishing process	**05 Hours / L5**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO36.1	Comprehend additive manufacturing principles, while demonstrating proficiency in Fusion Deposition Modeling's techniques with varied materials and explore diverse additive manufacturing techniques for practical industrial application.
CO36.3	Generate codes through slicing methodologies using Repetier Host, fostering innovation and problem-solving skills necessary to design complex 3D models for diverse industrial applications.
CO36.2	Develop 3D models using TinkerCAD and Autodesk Fusion 360 and generate STL files, enabling efficient product design and prototyping in modern industries.
CO36.4	Produce goods by skillfully operating a 3D printer, adeptly fine-tuning settings to match various material types and specific applications.
CO36.5	Implement post-processing techniques, ensuring product quality through precise inspection, defect identification.

TEXTBOOKS:

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer.
2. Samuel N Bernier, Design for 3D Printing - Scanning, Creating, Editing, Remixing, and Making in Three Dimensions, Shroff Publishers & Distributors Pvt Ltd, 2016

Reference books:

1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers.
2. 2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific.
3. 3. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021. E-Books /

Web References

- https://www.nist.gov/additive-manufacturing
- https://www.metal-am.com/
- http://additivemanufacturing.com/basics/
- https://www.3dprintingindustry.com/

MOOCs

NPTEL Course: ''Fundamentals of Additive Manufacturing Technologies''
https://nptel.ac.in/courses/112103306

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be 40 marks for theory 60 marks for practical sessions.

SL	Details	**Max. marks**
	SECTION – I	
1	Theory Questions (Answer any TWO out of FOUR) from Module 1 & Module 2	20 M
2	Theory Questions (Answer any TWO out of FOUR) from Module 3 & Module 4	20 M
	SECTION – II	
3	Development of 3D Model using relevant modelling software	20 M
4	Slicing of 3D model using relevant slicing software	10 M
5	Setting up the 3D printing equipment and printing the model using 3D printer (Group Experiment)	10 M
6	Post Processing (Group Experiment)	20 M
	Total	**100 Marks**

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Continuous Internal Evaluation (CIE): Two Tests are to be conducted for 40 marks each. The average of the two tests are taken for computation of CIE on a scale of 40. CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and tests.

Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses.

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	Quiz /OAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO36.1	1	2	-	-	-	-	1	-	-	-	-	2	2	-	-
CO36.2	1	3	1	1	2	-	-	1	-	1	-	2	2	-	-
CO36.3	1	3	2	-	-	-	-	-	-	1	-	2	2	-	-
CO36.4	1	3	2	1	2	-	1	-	1	-	1	2	2	-	-
CO36.5	1	2	-	1	-	-	1	-	1	-	-	2	2	-	-
Average	**1**	**3**	**2**	**1**	**2**	**-**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**-**	**-**

Low - 1: Medium - 2: High – 3

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IV SEMESTER

SYLLABUS

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SEMESTER – IV

Course: Transforms Calculus and Numerical Techniques

Course Code	**22MAT41C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of Mathematics in various fields of engineering by making them to learn:

CLO1	Laplace Transforms
CLO2	Fourier series and Fourier Transforms
CLO3	Numerical Methods

Content	No. of Hours/ RBT levels
Module 1 Laplace transforms of elementary functions, Unit-step and Dirac delta functions. Inverse Laplace Transforms, Solution of second order linear differential equations using Laplace transforms.	**08 Hours L2, L3**
Module 2 Fourier series of periodic functions, half range Fourier sine and cosine series. Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms.	**08 Hours L2, L3**
Module 3 Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson method. Finite differences: Newton's forward and backward difference formulae. Newton's divided difference formula and Lagrange's interpolation formula. Numerical integration: Simpson's 1/3rd, 3/8th, Weddle's rule.	**08 Hours L2, L3**
Module 4 Numerical solution of ordinary differential equations of first order and first degree using Modified Euler method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector methods. Numerical solution of second order ordinary differential equations: Runge-Kutta method and Milne's method.	**08 Hours L2, L3**
Module 5 One dimensional wave and heat equation. Solution of heat and wave equation by method of separation of variables. Two-dimensional heat flow, Solution of Laplace's equation, Laplace's equation in polar coordinates. Two dimensional wave equation. Numerical solution of heat and wave equations.	**08 Hours L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO41.1	Determine Laplace and inverse Laplace transforms of given functions and solve linear differential equations
CO41.2	Determine Fourier series and Fourier Transform of given function.
CO41.3	Apply numerical techniques to solve algebraic and transcendental equations.
CO41.4	Apply numerical techniques for interpolation and to evaluate definite integrals.
CO41.5	Solve ordinary differential equations of first and second order using single step and multistep numerical methods
CO41.6	Solve problems related to heat and wave equations

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006

Reference books:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6th Edition, 2014

Scheme of Examination: Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs: seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO41.1	3	2	1									3				
CO41.2	3	2	1									3				
CO41.3	3	2	1									3				
CO41.4	3	2	1									3				
CO41.5	3	2	1									3				
CO41.6	3	2	1									3				
Average	**3**	**2**	**1**									**3**				

Low-1: Medium-2: High-3

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SEMESTER – IV

Course: MECHANICAL MEASUREMENTS AND METROLOGY (Integrated)

Course Code	**22MED42**	**CIE Marks (Theory + Lab)**	**30 + 20 = 50**
Hours/Week (L: T: P)	**3 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Prerequisites: Engineering Physics

Course Objectives: This course will enable the students to

CLO1	Understand the standards of measurement, errors in measurement, limits and fits as applied to industrial specific standards.
CLO2	Know gauges, Basics of Geometrical Dimensioning and Tolerances.
CLO3	Know the types of comparators, principles and devices used for angular measurement.
CLO4	Understand static characteristics of measurement, types and principle of working of transducers.
CLO5	Understand the principles of strain, temperature and pressure measurement.

Content	**No. of Hours/ RBT levels**
Module 1 **Standards of measurement**: Definition and Objectives of metrology, line and end standard, Transformation from line standard to end standard, calibration of end standards, Characteristics/Numericals. Definitions and concept of accuracy, precision. Errors in measurement, classification of errors. **System of Limits, Fits, Tolerance and Gauges:** Definition of tolerance, principle of interchange ability and selective assembly. Concept of limits, size and tolerances, compound tolerances, Hole base system & shaft base system, Limit gauging, classification of gauges, Taylor's principle. **Laboratory:** *Laboratory Exercise – I, II*	**08 Hours / L2**
Module 2 **Geometrical Dimensioning and Tolerances:** History and Background of GD&T, Commonly Used GD&T Terms & Symbols, Material Condition Modifiers, Datum and features, Datum Reference Frame, Types of GD&T tolerances, Straightness, and flatness, Circularity and Cylindricity, Profile of a Line and Surface, Angularity, Perpendicularity, and Parallelism, Position, Concentricity and Symmetry, Circular and Total Runout, Virtual Condition. General Rules of GD & T. Machine tool metrology, machine tool tests to check for Straightness, Flatness, Parallelism, Squareness, Roundness, Cylindricity, Runout. **Laboratory:** *Laboratory Exercise – III*	**08 Hours / L3**
Module 3 **Comparators:** Introduction to Comparators, characteristics, and classification of comparators. Measurements using Autocollimator, NPL flatness interferometer, Laser interferometer. **Angular measurements**: Bevel Protractor, Sine Principle and use of Sine bars, Sine	**08 Hours / L3**

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centre, use of angle gauges, (numerical on building of angles) **Laboratory:** *Laboratory Exercise – IV, V and VI*	
Module 4 **Measurement systems and methods:** Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. **Transducers:** Transfer efficiency, primary and secondary transducers, and classification of transducers with examples. Quality attributes of transducers, intermediate modifying devices. **Measurement of Force and Torque:** Basic principles, proving ring, torque measurement, hydraulic dynamometer.	**08 Hours / L3**
Module 5 **Strain measurement**: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement. **Pressure and Temperature measurement**: Basic principles, use of elastic members, Bridgeman gauge, McLeod gauge, Thermocouple, Laws of Thermocouple, and Optical Pyrometer. **Laboratory:** *Laboratory Exercise – VII and VIII*	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO42.1	Interpret the concept of standards in measurement, tolerances, limits, fits and interchangeability in measurements.
CO42.2	Apply the concepts of geometrical tolerances in assemblies and industry components.
CO42.3	Inspect the process of linear and angular measurements as applied to a few machine made components.
CO42.4	Infer on the concept of principles of transducers and their measurement of force and torque.
CO42.5	Demonstrate the measurement of pressure, temperature and strain measurement.

Laboratory:

Exercise Number	Experiment	No. of Hours/RBT Levels
I & II	1. Calibration of Micrometer using slip gauges. 2. Calibration of Vernier caliper	**02 Hours/L3**
III & IV	3. Measurements of surface roughness using Tally Surf/Mechanical Comparator.	**02 Hours/L3**
V & VI	4. Measurement of angle using Bevel protractor 5. Measurement of angle using Sine Centre / Sine bar. 6. Measurements using Optical Projector	**04 Hours/L3**
VII VIII	7. Calibration of Load cell using standard weights 8. Calibration of Pressure Gauge using Bourdon tube measurement.	**02 Hours/L3**

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Textbooks:

1. **Beckwith Marangoni and Lienhard** Mechanical Measurements by, Pearson Education, 6th Ed.,2006.
2. **B C Nakra, K K Chaudhry** Instrumentation, Measurement and Analysis, McGraw–Hill, 4th Edition.
3. **R.K. Jain Engineering** Metrology, Khanna Publishers, 2009.

Reference books:

1. **N.V. Raghavendra and L. Krishnamurthy**, Engineering Metrology and Measurements, Oxford University Press.
2. **Ernest Deoblin**, Deoblin's Measurement system, Dhanesh manick, McGraw–Hill
3. **Bentley**, Engineering Metrology and Measurements, Pearson Education.

MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_me70/preview
2. https://nptel.ac.in/courses/112/106/112106138/

Scheme of Examination: (Integrated courses)
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Laboratory	**20**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO42.1	3	1	1	1		1	1	1	1	1		1			3
CO42.2	3	1	1	1		1	1	1	1	1		1			3
CO42.3	3	1	1	1		1	1	1	1	1		1			3
CO42.4	3	1	1	1		1	1	1	1	1		1			3
CO42.5	3	1	1	1		1	1	1	1	1		1			3
Average	**3**	**1**	**1**	**1**		**1**	**1**	**1**	**1**	**1**		**1**			**3**

Low - 1: Medium - 2: High – 3

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SEMESTER – IV

Course: MECHATRONICS

Course Code	22MED43	CIE Marks	50
Hours/Week (L: T: P)	2: 0 :2	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Familiarize with the fundamentals of IoT and Embedded systems.
CLO2	Get acquainted with the sensors and the actuators, which are commonly used in mechatronics systems.
CLO3	Impart knowledge about the Arduino Programming

Content	No. of Hours/ RBT levels
Module 1 **Introduction**: Definition of Mechatronics, evolution, elements of mechatronic system, Objective of mechatronics Advantages and Disadvantages of Mechatronics system, Applications of Mechatronics, Mechatronics design process, Control system – elements of measurement system, functions of control system, Open and closed loop control systems, Elements of a closed-loop system.	**8 Hours / L1, L2, L3**
Module 2 **Microprocessor & Microcontrollers**: Introduction, Microprocessor systems, Microcontrollers, Difference between microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology, Assembler, Registers: General purpose registers, temporary registers, Special purpose registers, Program Counter, Fetch and write cycle, state, bus interrupts, stack and stack pointer.	**8 Hours / L1, L2, L3**
Module 3 **Transducers and sensors**: Difference between transducer and sensor, Performance parameters of a Sensor / Transducers, Classification of transducers, Primary and secondary transducers. **Applications of sensors**: Photodiode, Photoresistor (LDR), Phototransistor, Ultrasonic Sensors, temperature sensors, LVDT, Capacitance sensors, force and torque sensors, Strain gauges, and Hall Effect sensors.	**8 Hours / L1, L2, L3**
Module 4 **DRIVES AND ACTUATORS:** Relays, Solenoids, DC motor: Brushed and Brushless type DC motors, AC Motor: Induction and Synchronous motors, stepper motors, Servo motor, PWM's – Pulse Width Modulation **Case Studies**: Automatic Washing Machine, Engine Management System, Automatic control of water level, Anti-lock braking system, Automatic car parking system.	**8 Hours / L1, L2, L3**

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Module 5	
Introduction to IoT: IoT basics, Arduino as microcontroller, prototyping with breadboard, Arduino programming, Interfacing LEDs, Buzzers, Switches, Sensors, DC motors, Servo motors with Arduino, PWM on Arduino	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO43.1	Analyze the basic components and principles of Mechatronics in practical settings.
CO43.2	Demonstrate a comprehensive understanding of their architecture, functionalities, and applications of Microprocessors & Microcontrollers
CO43.3	Demonstrate an understanding of transducers and sensors, encompassing their functionalities, classifications, and principles of operation
CO43.4	Select drives and actuators like relays, solenoids, and AC & DC motors effectively in various industrial settings
CO43.5	Demonstrate practical embedded programming skills through coding, debugging Arduino-based programs for sensors, actuators, and control systems.

Textbooks:

1. W Bolton. (2019). Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education, Sixth Edition, pp. 1-682.
2. D. Shetty and R. Kolk. (2011). Mechatronics System Design, 2nd edition, SI Global Engineering

Reference books:

1. Mechatronics – HMT. (2000). Tata McGraw Hill Publishing Company Ltd.
2. David G. Alciatore and Michael B Histand. (2007). Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, Third Edition.
3. Robert H. Bishop. (2002). The Mechatronics Handbook, CRC Press.

E-Books / Web References

1. https://docs.arduino.cc/learn/starting-guide/getting-started-arduino/
2. https://howtomechatronics.com/

MOOCs

1. NPTEL Course: "Mechatronics" https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. NPTEL Course: "Design of Mechatronic Systems" https://onlinecourses.nptel.ac.in/noc21_me129/preview

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

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Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /OAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO43.1	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO43.2	2	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO43.3	2	3	1	-	-	1	-	-	-	-	-	2	2	-	-
CO43.4	2	3	1	-	-	1	-	-	-	-	-	2	2	-	-
CO43.5	2	3	3	2	2	1	1	-	1	-	1	2	2	-	-
Average	2	3	2	2	2	1	1	-	1	-	1	2	2	-	-

Low - 1: Medium - 2: High – 3

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SEMESTER – IV

Course: THEORY OF MACHINES

Course Code	**22MED44**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2 : 2 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Impart knowledge on various types of mechanisms and their inversions.
CLO2	Familiarize with motion transmission elements of spur gear, gear trains and cams.
CLO3	Understand the static force analysis of four bar and Slider-crank mechanisms graphically.
CLO4	Understand the gyroscopic effect on aeroplane, ship, two & four wheel vehicle.
CLO5	Understand the need for balancing of rotating to achieve static & dynamic equilibrium conditions.

Content	**No. of Hours/ RBT levels**
Module 1 **Fundamentals of Mechanisms**: Kinematic Link & pairs, Classification of kinematic pairs, Constrained motion & its types, Kinematic chain, Mechanism, Degrees of freedom, Mobility of mechanism & Grubbler's criteria. List the Inversions of Four bar chain, Slider crank chain and Double slider crank chain. **Inversion Mechanisms:** Quick return motion mechanisms - Crank and slotted lever Mechanism. Straight-line motion mechanisms: Peaucellier's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.	**08 Hours / L3**
Module 2 **Gears:** Gear terminology, Law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, Expressions for minimum number of teeth to avoid interference (No derivations), Numerical on spur gear. **Gear Trains:** Simple gear trains, Compound gear trains, Reverted gear train, Epicyclic gear trains: Method to find Velocity ratio Or train value - Tabular method. Torque calculation in epicyclic gear trains.	**08 Hours / L3**
Module 3 **Cams:** Classification of cams & followers, Cam nomenclature, Follower motions: Uniform velocity (UV), Uniform acceleration and deceleration (UARM), Simple harmonic motion (SHM), & cycloidal motion. Cam profiles: cam profiles with knife-edge follower & roller follower (Inline & offset).	**08 Hours / L3**

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Module 4 **Static force Analysis:** Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism (**Graphical method**). **Gyroscope:** Principle of gyroscope, gyroscopic couple. Effect of gyroscopic couple on aeroplane, ship, stability of two wheelers and four wheelers (**No derivations for 2 & 4 wheelers**), numerical problems.	**08 Hours / L3**
Module 5 **Balancing of Rotating Masses:** Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in the same plane and in different planes.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO44.1	Analyze the kinematic mechanisms & their inversions for various applications.
CO44.2	Analyze speed and torque in gear trains with knowledge of spur gear terminologies.
CO44.3	Illustrate CAM profiles with an acquaintance of follower motions.
CO44.4	Examine static equilibrium conditions for four-bar & slider-crank mechanisms.
CO44.5	Analyze the gyroscopic effect in the context of stabilization of aeroplane, ship, two & four-wheeler vehicles.
CO44.6	Assess static & dynamic equilibrium conditions for rotating masses.

Textbooks:

1. **Rattan S.S,** Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2. **Uickers, J J, Pennock G R & Shigley J E,** Theory of Machines & Mechanisms, SI Edition, OXFORD University Press, 3rd Edition 2009.

Reference books:

1. **Sadhu Singh**, Theory of Machines, Pearson Education (Singapore) Pvt Ltd, Indian Branch New Delhi, 2nd Edition 2006.
2. **P. L. Ballaney**, Theory of Machines and Mechanisms, Khanna Publications – 2003.
3. **Thomas Bevan**, Theory of Machines, Pearson Education Ltd., 3rd Edition, 2010.
4. **A. G. Ambekar**, Mechanism and Machine Theory, PHI, 2007.
5. **Dr. R K Bansal, Dr. J S Brar**, Theory of Machines, Laxmi Publications (New Delhi), 5th Edition 2016.

E-Books / Web References

1. Text Book: Robt. F. McKay, The Theory of Machines (https://archive.org/details/theoryofmachines00mckarich)
2. Text Book: Theory of Machines, Sadhu Singh, 3rdEdition. 2011, Pearson, Kindle Edition (http://www.cs.cmu.edu/~rapidproto/mechanisms/tablecontents.html)
3. https://ekeeda.com/degree-courses/mechanical-engineering/theory-of-machines

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MOOCs

1. NPTEL Course: "Kinematics of Machines" (http://nptel.ac.in/courses/112104121/1)
2. NPTEL Course: "Kinematics of Machines" https://nptel.ac.in/courses/112/105/112105268/
3. NPTEL Course : "Dynamics of Machines" https://nptel.ac.in/courses/112/101/112101096/
4. NPTEL Course : "Dynamics of Machines" https://nptel.ac.in/courses/112/104/112104114/

Scheme of Examination: (Theory courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment/Quiz would be for a total of 10 marks.
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO44.1	3	2	2	1		1	1						2		
CO44.2	3	2	2	1		1	1						2		
CO44.3	3	2	2	1		1	1						2		
CO44.4	3	2	2	1		1	1						2		
CO44.5	3	2	2	1		1	1		1	1			2		
CO44.6	3	2	2	1		1	1		1	1			2		
Average	**3**	**2**	**2**	**1**		**1**	**1**		**1**	**1**			**2**		

Low - 1: Medium - 2: High – 3

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SEMESTER – IV

Course: THERMODYNAMICS

Course Code	22MED45	CIE Marks	50
Hours/Week (L: T: P)	2 : 2 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: The students will be taught:

CLO1	The fundamental concepts, terms and terminologies involved in thermodynamics
CLO2	To Identify and describe energy exchange processes (in terms of various forms of energy, heat, and work) in thermodynamic systems using basic laws
CLO3	The fundamental concepts of basic vapor power and refrigeration cycles
CLO4	The application of basic principles in a systematic way to analyze basic thermodynamic cycles.
CLO5	The testing of IC engines and calculation of performance parameters.

Content	No. of Hours/ RBT levels
Module 1 **Introduction, Basic Concepts**: Thermodynamic system and control volume, Microscopic and macroscopic point of view, thermodynamic properties, state of a substance, process and cycle, Thermodynamic equilibrium, Concept of Continuum, Quasi-static process, The Zeroth Law of Thermodynamics, Temperature scales, simple numerical. **First law of Thermodynamics**: First law for a closed system undergoing a cycle and change of state, energy, PMM1, first law of thermodynamics for steady flow process, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger and throttling process, simple numerical.	**08 Hours / L1, L2, L3**
Module 2 **Second law of thermodynamics**: Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, causes of irreversibility, Carnot theorem, and simple numerical. **Entropy**: Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow Processes, simple numerical.	**08 Hours / L1, L2, L3**
Module 3 **Pure Substances:** Properties of pure substances, Water and steam – Constant temperature and constant pressure heating. **Vapor Power cycles**: Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, calculation of cycle efficiencies, simple numerical **Refrigeration Cycles:** Simple Vapor Compression Refrigeration (VCR) cycle on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, Reversed Carnot cycle and its limitation, Bell-Coleman cycle, simple numerical.	**08 Hours / L1, L2, L3**

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Module 4 **Air Standard Cycles:** Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T -s diagrams, description, efficiencies (no derivations) and mean effective pressures (no derivations). Comparison of Otto, Diesel, dual cycles, simple numerical on Otto and Diesel cycle. **Gas Turbine cycles**: Simple Brayton cycle, open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency (no derivation), work ratio, simple numerical.	**08 Hours / L1, L2, L3**
Module 5 **Internal Combustion Engines**: Performance parameters-calculations and its measurements - Motoring method, Willian's line method, dynamometers-mechanical, electrical, and hydraulic, Air box method, Morse test, Valve timing diagram, heat balance sheet, engine performance curves, simple numerical.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO45.1	Describe the fundamental principles of thermodynamics and apply the laws of thermodynamics to estimate the performance parameters of thermal systems.
CO45.2	Apply laws of thermodynamics and the concept of entropy to solve engineering problems involving closed and open systems by making proper assumptions
CO45.3	Estimate the performance of basic vapour power cycles and Refrigeration systems using corresponding thermodynamic property tables and charts.
CO45.4	Analyze the thermodynamic cycles of various thermal systems.
CO45.5	Demonstrate the knowledge of the energy conversion and performance characteristics of internal combustion engines applied to real time applications.

Textbooks:

1. **P K Nag,** Basic and Applied Thermodynamics, Tata McGraw-Hill, 2nd Edition, 2017
2. **R K Rajput,** Thermal Engineering, Lakshmi Publication, 10th Edition, 2018.

Reference books:

1. **Yunus A Cengel, Michael A Boles,** Thermodynamics-An Engineering Approach, McGrawHill Education, 9th Edition,2019.
2. **V Ganesan,** Internal Combustion Engines, McGraw-Hill, 4th Edition, 2017.

E-Books / Web References

1. Working of IC engine, https://www.youtube.com/watch?v=DZt5xU44IfQ
2. Working of Refrigerator, https://www.youtube.com/watch?v=7NwxMyqUyJw
3. Working of Thermal Power Plant, https://www.youtube.com/watch?v=IdPTuwKEfmA

MOOCs

1. https://nptel.ac.in/courses/127106135
2. NPTEL Course on APPLIED THERMODYNAMICS FOR ENGINEERS by Dr. Dipankar N. Basu, Associate Professor, Department of Mechanical Engineering, Indian Institute of Technology Guwahati https://nptel.ac.in/courses/112/103/112103275/

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3. NPTEL Course on ENGINE EMISSIONS by Prof B P Pundir, Department of Mechanical Engineering, Indian Institute of Technology Kanpur https://nptel.ac.in/courses/112/104/112104033/

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in each test is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO45.1	3	2	2	1		1						1		1	
CO45.2	3	2	2	1		1						1		1	
CO45.3	3	2	2	1		1	1					1		1	
CO45.4	3	2	2	1		1	1					1		1	
CO45.5	3	2	2	1		1	1					1		1	
Average	**3**	**2**	**2**	**1**		**1**	**1**					**1**		**1**	

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: Ability Enhancement Course - II

Automation through Hydraulics & Pneumatics

Course Code	**22MED46**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2: 0: 2**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Physics.

Course Objectives: To enable students to apply the knowledge of hydraulics and pneumatics in broad domain of mechanical engineering by making them to learn:

CLO1	Components used in Hydraulics and Pneumatics
CLO2	Identify different control valves used in Hydraulics and Pneumatics
CLO3	Construction of Hydraulic Circuits
CLO4	Construction of Pneumatic Circuits

Content	**No. of Hours/ RBT levels**
Module 1 **Introduction to fluid power systems:** Components and structure of Hydraulics & Pneumatic systems. Advantages, disadvantages and applications. Hydraulic and Pneumatic components – compressor, valves and actuators. Working principle of actuators and valves with symbols and basic circuit preparation. Fault detection and identification in hydraulic and pneumatic circuits **Experiments on Hydraulic Kit** 1. Direct & Indirect control of double acting hydraulic cylinder. 2. Speed Control of Double acting cylinder using Meter in circuit. **Open Ended Experiment**: Speed Control of Double acting cylinder using Meter out circuit.	**10 Hours / L2**
Module 2 **Multi- Cylinder Application:** Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, practical application examples (up to two cylinders) using cascading method (using reversing valves). Introduction to Siemens Diagnostic Kit **Open ended experiments of Industrial Facult detection and control**.	**10 Hours / L2**

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Module 3 **Signal Processing Elements:** Use of Logic gates. **Experiments on Pneumatics** 1. Raising and lowering of the ladle using double piloted 5/2 directional control valve 2. Pin Feeding Device with speed control using Flow control valve 3. Direct & Indirect control of single and double acting pneumatic cylinders **Open Ended Experiment**: Billiards balls distribution from a gravity magazine using Logic gates.	**10 Hours / L3**
Module 4 **Electro- Pneumatic Control:** Principles - signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application **Open ended experiments of Industrial Fault detection and control**	**10 Hours / L3**

	Component	Marks	Total Marks
CIE	**Construction and Execution of Hydraulics & Pneumatic Circuits and Fault Detection of Circuits**	**30**	**50**
	Internal Assesment Test	**20**	

Scheme of Examination:
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions from module 1 & 2 carrying 20 marks each. Students are required to answer both the questions**.**
Module 1,2,3 & 4 is based on conduction of experiments on hydraulic and pneumatic kit. There will be One experiment from each module carrying 30 marks each. Students are required to conduct two experiments).

COURSE OUTCOMES: Upon completion of this course, student will be able to

CO46.1	**Analyze** the working principles of hydraulic and pneumatic systems, and assess their applications in industrial automation.
CO46.2	Evaluate the operation and functionality of pneumatic and hydraulic control valves and differentiate their roles in various control systems.
CO46.3	**Design** hydraulic control circuits by applying advanced principles of fluid dynamics and control strategies to solve complex engineering problems.
CO46.4	**Simulate** pneumatic control circuits using signal processing elements and optimize their performance for real-world automation applications.

Textbooks:

1. **Anthony Esposito** Fluid Power with Applications, Sixth edition, Pearson Education, Inc, 2000.
2. **Andrew Parr** 'Pneumatics and Hydraulics', Jaico Publishing Co

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Reference books:

1. **S. R. Majumdar** Oil Hydraulic systems', Principles and Maintenance, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **Pippenger,** Hicks Industrial Hydraulics, " McGraw Hill, New York

E-Books / Web References

1. https://www.just.edu.jo/~haalshraideh/Courses/IE431/Lecture_slides/Hydrolics%20and%20Pneumatics.pdf

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO46.1	3	2	1		1	1			2	2		1			3
CO46.2	3	2	1		1	1			2	2		1			3
CO46.3	3	2	1		1	1			2	2		1			3
CO46.4	3	2	1		1	1			2	2		1			3
Average	3	2	1		1	1			2	2		1			3

Low - 1: Medium - 2: High - 3

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SEMESTER – IV

Course: MACHINE SHOP

Subject Code	**22MEDL47**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 1**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to

CLO1	Guide students to use fitting tools to perform fitting operations.
CLO2	Provide an insight to different machine tools, accessories, and attachments.
CLO3	Train students into machining operations to enrich their practical skills.
CLO4	Inculcate team qualities and expose students to shop floor activities.

Sl. No.	**Experiments**	**No. of Hours/ RBT levels**
	Part- A	
1	Introduction to lab and safety measures, study the constructional features of Lathe, Milling, Drilling and Shaping machines with the help of sketches and diagrams, role of machining in industries. Preparation of at least two fitting models by proficient handling and application of hand tools.	**06 Hours / L3**
	Part - B	
1	**Lathe work** – Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning. Selection of cutting parameters and machining time calculation Analysis of chip formation and chip reduction coefficient in turning of mild steel by HSS tool with different depth of cut, speed, and feed rate.	**06 Hours / L3**
2	**Milling machine** – Usage of milling cutters to understand face milling, plain milling and end milling on vertical milling machine and Produce T-slots, Perform cutting of gear teeth on horizontal milling machine	**04 Hours / L3**
3	**Drilling machine** – Produce holes and carry out operations such as boring, reaming and threading and perform simple calculations based on selection parameters.	**04 Hours / L3**
	Part – C	
1	Demonstration of surface grinding on flat surfaces	**01 Hours / L3**
2	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.	**01 Hours / L3**

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3	Demonstration of CNC lathe and milling machine	**02 Hours / L3**
4	Cutting force measurement with dynamometers (Demonstration) for turning, drilling, grinding operations.	**02 Hours / L3**
5	Experiment on anyone advanced machining process	**02 Hours / L3**
6	Demonstration / Experiment on tool wears and tool life on anyone conventional machining process.	**02 Hours / L3**
7	To study the tool geometry of a single point turning tool (SPTT) in the American Standards Association (ASA) system.	**02 Hours / L3**

Course Outcomes: Upon successful completion of this course, student will be able to

CO47.1	Analyze the working mechanisms of conventional machine tools and interpret their functionalities in various manufacturing processes.
CO47.2	Select and justify the appropriate hand tools and cutting tools required for specific material removal processes.
CO47.3	Fabricate fitting models according to given drawings using hand tools, demonstrating precision and accuracy.
CO47.4	Manufacture components to specified tolerances and dimensions using various operations on a lathe machine.
CO47.5	Engineer components with precise gear teeth, slots, grooves, and holes to specified requirements using milling, shaping, and drilling machines, optimizing the processes for efficiency and quality.

Textbooks:

1. **P N Rao**, Manufacturing Technology Vol I & II, 5th Edition
2. **Sharma P C**, A textbook of Production Technology Vol I and II, S Chand and Company Ltd., New Delhi.

References:

1. **Chapman W A,** Workshop technology Vol I & Vol II
2. **Hajra Choudhary S K and Hajra Choudhary A K,** Elements of Manufacturing technology Vol II

Website references:

1. https://nptel.ac.in/courses/112/105/112105233/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/machine_tools/labs/index.php

Scheme of Examination:

Semester End Examination (SEE):

One model using Lathe machine	**40 Marks**
One model using Milling / Shaping / Drilling	**40 Marks**
Viva Voce	**20 Marks**

Note: SEE will be conducted for 100 Marks and reduced to 50

Continuous Internal Evaluation (CIE):

Weekly performance - Lab participation + Report	**30 Marks**
One Internal Assessment at the end of semester	**20 Marks**

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CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO47.1	3	3	2			1	1	1	3	1		2			3
CO47.2	3	3	2			1	1	1	3	1		2			3
CO47.3	3	3	2			1	1	1	3	1		2			3
CO47.4	3	3	2			1	1	1	3	1		2			3
CO47.5	3	3	2			1	1	1	3	1		2			3
Average	3	3	2			1	1	1	3	1		2			3

Low - 1: Medium - 2: High – 3

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V - VI SEMESTER
SCHEME AND SYLLABUS
Department of
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B.E. in Mechanical Engineering Scheme of Teaching and Examinations 2023

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

V SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	HSMS	22MED51	Industrial Management & Economics	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	IPCC	22MED52	Fluid Mechanics Machinery	TD:ME PSB:ME	2	2	2		03	50	50	100	4
3	PCC	22MED53	Machine Design	TD: ME PSB:ME	3	2	0		03	50	50	100	4
4	PCCL	22MEDL54	CNC Programming Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
5	PEC	22MED55x	Professional Elective - I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
6	PROJ	22MEDP56	Mini Project	TD: ME PSB:ME	0	0	4		03	100	-	100	2
7	AEC	22RMIK57	Research Methodology and IPR	Any Department	3	0	0		03	50	50	100	3
8	MC	22CIVK58	Environmental Studies	TD: CV/Env/Chem PSB:CV	2	0	0		02	50	50	100	2
9	MC	22NSK59	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		22PEK59	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YOK59	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**22**

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Professional Elective Course - I			
22MED55A	Mechanical Vibrations	22MED55C	Supply Chain Management & Introduction to SAP
22MED55B	Product Life Cycle Management	22MED55D	Automation in Manufacturing

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course.

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batchmates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

VI SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self -Study	Duration inhours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED61	Finite Element Methods	TD: ME PSB:ME	2	2	0		03	50	50	100	3
2	IPCC	22MED62	Heat Transfer	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PEC	22MED63x	Professional Elective - II	TD: ME PSB:ME	3	0	0		03	50	50	100	3
4	OEC	22MED64x	Open Elective -I	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	PROJ	22MEDP65	Major Project Phase - I	TD: ME PSB:ME	0	0	4		03	100	-	100	2
6	PCCL	22MEDL66	Analysis Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	AEC/ SDC	22MED67x	Ability Enhancement Course/ SkillDevelopment Course - III	TD & PSB: Concerned Department	If the course is offered as a Theory: 2	0	0		01	50	50	100	2
					If course is offered as a practical: 1	0	2						
8	MC	22UHK68	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	-	100	0
		22PEK68	Physical Education (PE) (Sports and Athletics)	Physical Education Director							-		
		22YOK68	Yoga	Yoga Teacher							-		
9	IKS	22IKSK69	Indian Knowledge System	Any Department	1	0	0		01	50	50	100	0
10	MC	22UHV69	Universal Human Values	Any Department	1	0	0		01	50	50	100	0
									Total	**600**	**400**	**1000**	**18**

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Professional Elective Course- II			
22MED63A	Design of Transmission Elements	22MED63C	Project and Operations Management
22MED63B	Refrigeration and Air Conditioning	22MED63D	Renewable Energy Technologies
Open Elective Course - I			
22MED64A	Supply Chain Management & Introduction to SAP	22MED64C	Total Quality Management
22MED64B	Operations Research	22MED64D	Modern Mobility
Ability Enhancement Course / Skill Enhancement Course - III			
22MED67A	Basics of MATLAB	22MED67C	Introduction Augmented Reality
22MED67B	Fundamental of Virtual Reality ARP Development	22MED67D	Simulation and Analysis using Ansys workbench

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **K :** The letter in the course code indicates common to all the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional Elective Course. **PROJ**: Project Phase -I, **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulationgoverning the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

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V SEMESTER

SYLLABUS

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SEMESTER – V

Course: Industrial Management & Economics

Course Code	22MED51	CIE Marks	50
Hours/Week (L: T: P)	3: 0: 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: NiL

Course Objectives: To provide an insight to**,**

CLO1	Understand needs, functions, roles, scope and evolution of Management.
CLO2	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CLO3	Describe the understanding of motivation and different control system in Management.
CLO4	Understand various interest rate methods and implement the suitable one.
CLO5	Select the best economic model from various available alternatives.
CLO6	Estimate various depreciation values of commodities.

Content	No. of Hours/ RBT levels
Module 1 **Management: Introduction** - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management. **Planning:** Nature, importance and purpose of planning process, Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.	**08 hrs** **L1,L2,L3**
Module 2 **Organizing and Staffing:** Nature and purpose of organization Principles of organization - Types of organization - Centralization Vs Decentralization of authority and responsibility. Nature and importance of staffing--Process of Selection & Recruitment (in brief). **Directing & Controlling**: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance. Meaning and steps in controlling - Essentials of a sound control system.	**08 hrs** **L1,L2,L3**
Module 3 **Introduction:** Engineering and economics, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns. Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.	**08 hrs** **L1,L2,L3**

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Module 4 **Present, future and annual worth and rate of returns:** Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons. Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.	**08 hrs** **L1,L2,L3**
Module 5 **Costing and depreciation:** Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, and service output methods.	**08 hrs** **L1,L2,L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO51.1	**Explain** the development of management and the role it plays at different levels in an organization.
CO51.2	**Select** the process and role of effective planning, organizing and staffing for the development of an organization.
CO51.3	**Implement** good leadership, communication and coordination for establishing effective control in an organization.
CO51.4	**Understand** engineering economics demand supply and its importance in economic decision making and problem solving.
CO51.5	**Calculate** present worth, annual worth and IRR for different alternatives in economic decision making.
CO51.6	**Understand** the procedure involved in estimation of Cost for a simple component, Product costing and depreciation, its methods.

Textbooks:

1. Principles of Management – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 5th Edition 2012.
2. Engineering Economy Riggs J.L McGraw Hill 4th edition.

Reference books:

3. Mechanical estimation T.R. Banga& S.C. Sharma Khanna Publishers 17th edition 2015
4. Engineering Economy Thuesen H.G PHI 2002
5. Management and Entrepreneurship – N.V.R. Naidu & T. Krishna Rao, I.K. International, New Delhi – 2008
6. Engineering Economy Thuesen H.G PHI 2002

E-Books / Web References

1. **https://www.youtube.com/watch?v=vOykcERGw9Y- Principles of management**
2. https://drive.google.com/file/d/1O871eMrnRA84N2d2dmRKA5Rtel4QdJ6y/view - Engineering Economics -R. Panneerselvam

MOOCs

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1. **https://nptel.ac.in/courses/110105075 - Foundation Course in Managerial Economics**
2. **https://nptel.ac.in/courses/122106031- Management Concepts**

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. An average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and an average of three tests. One quiz is to be conducted and evaluated for 10 marks.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	AAT/Quiz	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO51.1	2	-	-	-	-	1	-	-	-	-	3	1	-	-	3
CO51.2	3	-	-	-	-	1	-	2	-	-	3	1	-	-	3
CO51.3	2	-	-	-	-	1	-	1	1	1	3	1	-	-	3
CO51.4	3	-	-	-	-	1	-	-	-	-	3	1	-	-	3
CO51.5	3	2	-	-	-	1	-	-	-	-	3	1	-	-	3
CO51.6	2	1	-	-	-	1	-	-	-	-	3	1	-	-	3
Average	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**2**	**1**	**1**	**3**	**1**	**-**	**-**	**3**

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: FLUID MECHANICS AND MACHINERY

Course Code	22MED52	CIE Marks	50
Hours/Week (L: T: P)	2 : 2 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Physics, Basics of Mathematical concepts learnt in the 1st year of Mathematics.

Course Objectives: To enable students to apply the knowledge of fluid machinery in broad domain of mechanical engineering and henceforth they will be taught:

CLO1	The basics of fluid properties and measurement of pressure
CLO2	Working of a turbomachine and its correlation to Thermodynamics
CLO3	Working Principle, Model studies of Hydraulic Turbines
CLO4	Working Principle, Model studies of Steam Turbines
CLO5	Principle or working, slip and cavitation in Centrifugal and reciprocating Pumps

Content	No. of Hours/ RBT levels
Module 1 **Basics:** Introduction, types of fluid, - viscosity, surface tension, capillarity, vapour pressure & cavitation, Numerical problems. (No derivations). **Fluid Kinematics:** Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Assumptions, Navier Stokes Equation, Bernoulli's equation for real fluid, Applications of Bernoulli's equation (Venturi meter, Orifice meter, pitot tube) Numerical problems. No Derivations	**08 Hours / L3**
Module 2 **Fluid Dynamics:** Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Assumptions, Navier Stokes Equation, Bernoulli's equation for real fluid, Applications of Bernoulli's equation (Venturi meter, Orifice meter, pitot tube) Numerical problems. No Derivations **Introduction and Basics:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification of turbomachines. Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles – Principle and Types Numerical Problems. (No derivations). **Laboratory Exercise**: Experiment I, II, III, IV	**08 Hours / L3**
Module 3 **Hydraulic Turbines:** Classification, various efficiencies. Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems. Franci's turbine – Principle of working, velocity triangles, design parameters, and numerical problems. Kaplan and Propeller turbines - Principle of working, velocity triangles, design	**08 Hours / L3**

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parameters and Numerical Problems. Theory and types of Draft tubes. (No Derivations) Concepts of Specific Speed and Model Studies, (No Derivations) **Laboratory Exercise:** Experiment V, VI and VII	
Module 4 **Steam Turbines:** Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems. Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems Concepts of Specific Speed and Model Studies, (No Derivations)	**08 Hours / L3**
Module 5 **Centrifugal Pumps:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Problems, (No Derivations). **Reciprocating Pumps:** Classification and parts of centrifugal pump, Working, Discharge, Work done by a single stage pump, double stage pump, Slip of a reciprocating pump, Numerical Problems, (No Derivations) **Laboratory Exercise:** Experiment VIII, IX and X	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO52.1	Evaluate the properties of fluids and analyze the mechanics of fluids at rest to solve complex engineering problems.
CO52.2	Synthesize and integrate the basic principles and equations of fluid mechanics and turbomachines to design and optimize fluid systems.
CO52.3	Formulate and implement advanced applications of Euler's equation to enhance the performance and efficiency of hydraulic turbines.
CO52.4	Critically assess and correlate the principles of steam turbines with specific speed and model studies to innovate and improve turbine designs.
CO52.5	Design and evaluate centrifugal and reciprocating pump systems based on an in-depth understanding of their working principles to address complex fluid transport challenges.

Exercise Number	Experiment	No. of Hours/ RBT Levels
I, II, III, IV	Calibration of flow measuring devices – Orifice Meter, Nozzles, Venturi meter and V- Notch	04 Hours/ L3
V, VI, VII	Performance on hydraulic Turbines-Pelton wheel, Francis Turbine and Kaplan Turbines	02 Hours/ L3
VIII, IX and X	Performance hydraulic Pumps a. Single stage and multistage centrifugal pumps b. Reciprocating pump	04 Hours/ L3

Textbooks:

1. Dr R K Bansal, Fluid Mechanics: Lakshmi Publication 10th Edition/ 2018.
2. V Kadambi, Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery.

Reference books:

1. S M Yahya, Turbines, Fans and Compressors, Tata McGraw Hill, 2nd Edition
2. D.G. Shepherd, Principles of Turbomachines MacMillan, 1964

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E-Books / Web References

1. Principles of Turbomachinery https://engineeringvideolectures.com/course/805 Fundamentals of Turbomachinery
2. https://books.google.co.in/books?id=3NXzbV_YW_oC&printsec=copyright&redir_esc=y#v=onepage&q&f=false

MOOCs

1. https://onlinecourses.nptel.ac.in/noc21_me75/preview
2. https://nptel.ac.in/courses/112106200

Scheme of Examination:
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**
The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO52.1	3	3	2	2			2		1	1				2	
CO52.2	3	3	2	2			2		1	1				2	
CO52.3	3	3	2	2			2		1	1				2	
CO52.4	3	3	2	2			2		1	1				2	
CO52.5	3	3	2	2			2		1	1				2	
Average	**3**	**3**	**2**	**2**			**2**		**1**	**1**				**2**	

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: MACHINE DESIGN

Course Code	22MED53	CIE Marks	50
Hours/Week (L: T: P)	3 : 2 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Strength of Materials

Course Objectives: The students will be taught:

CO1	The steps in mechanical design procedure, materials, codes and use of standards and design for static strength, stress concentration
CO2	Analyze and design machine components for impact and fatigue strength.
CO3	Concepts and design of shafts, couplings and keys
CO4	to analyze and design riveted joints and welded joints
CO5	The design of pin joints and power screws.

Content	No. of Hours/ RBT levels
Fundamentals of Mechanical Engineering Design: Design process, Review of engineering materials and their properties and manufacturing processes, use of codes and standards, Factor of safety. Failure of brittle and ductile materials. Classification of stresses. **Theories of failure:** Maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, maximum principal strain theory. (No Numerical) **Design for Static Strength:** Numerical on Machine elements subjected to Normal, Bending, Shear and Combined stresses. (No Numerical related to brackets and crank)	**10 Hours / L1, L2, L3**
Module 2 **Stress concentration:** Stress concentration factor, methods of reducing stress concentration, Numerical on stress concentration factors. **Fatigue Loads:** Introduction to fatigue failure, Mechanism of fatigue failure (R-R Moore Rotating beam test), Endurance limit. Modifying factors: size effect, surface effect, Stress concentration effects Notch sensitivity, Soderberg and Goodman relationships. (No numerical on combined fatigue loading)	**10 Hours / L1, L2, L3**
Module 3 **Design of Shafts:** Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications. **Design of keys and couplings:** Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling types and applications, design of Flange coupling, and Bush and Pin type coupling.	**10 Hours / L1, L2, L3**

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Module 4 **Riveted Joints:** Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications **Types of Welded joints:** Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications	**10 Hours / L1, L2, L3**
Module 5 **Cotter and Knuckle joints:** Introduction to temporary joint, Design of cotter joint, Design of Knuckle joint. **Threaded fasteners:** Design of fasteners, load acting parallel to the axis of the bolts (rectangular and circular base), load acting perpendicular to the axis of the bolts, load acting in a plane of bolts.	**10 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to:

CO53.**1**	Apply codes and standards, design processes, and failure theories to design and optimize machine members under static loads.
CO53.**2**	Analyze and mitigate stress concentration effects in machine members to enhance their resilience against fatigue loads.
CO53.**3**	Synthesize solutions for shafts, keys, and couplings by solving complex loading problems and optimizing their performance.
CO53.**4**	Evaluate the performance and reliability of structures utilizing various types of riveted and welded joints.
CO53.**5**	Optimize the design of knuckle and cotter joints and determine the appropriate size of threaded fasteners for effective motion transmission between machine elements.

TEXTBOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HAND BOOK:

1. **Design Data Handbook, Volume 1,** K. Lingaiah, McGraw Hill, 2nd Ed.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. **Design of Machine Elements,** M. F. Spotts, T. E. Shoup, L. E Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. **Machine Design,** Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

WEB/ONLINE REFERENCES

www.nptel.ac.in

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MOOCs

1. NPTEL Course: "Design of Machine Elements"
   http:// https://nptel.ac.in/courses/112/107/112107146/#

2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Machine Design",
   (https://www.coursera.org/courses?query=mechanics%20of%20materials)
4. Free Video Lectures: "Design of Machine Elements",
   (https://freevideolectures.com/course/96/)

Scheme of Examination: (Theory courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments:

Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO53.**1**	3	2	2	1		1	1			1		2	2		
CO53.**2**	3	2	2	1		1	1			1		2	2		
CO53.**3**	3	2	2	1		1	1			1		2	2		
CO53.**4**	3	2	2	1		1	1			1		2	2		
CO53.**5**	3	2	2	1		1	1			1		2	2		
Average	**3**	**2**	**2**	**1**		**1**	**1**			**1**		**2**	**2**		

Low - 1: Medium - 2: High – 3

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SEMESTER – V

CNC Programming Laboratory

Course Code	22MEDL54	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	01	Examination Hours	03

Course Objectives: To enable students to apply the knowledge CNC Technology in broad domain of mechanical engineering by making them to learn:

CLO1	Fundamentals of CNC Machines and its construction
CLO2	Programming CNC machine operated on FANUC Controller
CLO3	Operation of CNC Turning center

DAY	Topic
Week 1	Lecture: Elements of CNC Turning center. Activity: Identification of parts of CNC Turning center
Week 2	Lecture: Modes of operation in CNC Turning center. Activity: Description of control panel of CNC Turning center with a neat sketch
Week 3	Lecture: CNC Programming basics– Introduction to CNC Programming, List of G – and M- codes, Absolute and Incremental modes, Coordinate system Activity 1: Listing of Coordinate points for the given component. Activity 2: Description of G- codes and M- codes
Week 4	Lecture: CNC Programming – Step Turning using turning cycle (G71) Activity: Developing CNC Program for the given component using turning cycle (G71)
Week 5	Lecture: CNC Programming – Grooving Cycle (G75) Activity: Developing CNC Program for the given component using Grooving Cycle (G75)
Week 6	Lecture: CNC Programming – Threading Cycle (G76) Activity: Developing CNC Program for the given component using Threading Cycle (G76)
Week 7	Demonstration: X- and Z- offsets in CNC Turning center Activity: To perform offset for the given component
Week 8	Project: Develop a CNC Program for the given component using G71, G75 and G76 cycles
Week 9	Project: Perform offset and produce the component using CNC Turning center
Week 10	Project: Quality checks and Report writing

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO54.**1**	Develop part programming using G- and M- codes
CO54.**2**	Set up the CNC machining center for manufacturing
CO54.**3**	Produce the parts on CNC Turning Machine

Textbooks:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be 40 marks for theory 60 marks for practical sessions.

SL	Details	**Max. marks**
	SECTION – I	
1	Develop a CNC Program for the given component using G71, G75 and G76 cycles	30 M
2	Perform offset on CNC urning center.	30 M
3	Produce the component using CNC Turning center	40 M

Continuous Internal Evaluation (CIE):
CIE1 is based on the development of CNC Program for the given component
CIE2 is based on the submission of the project and report writing
Tests are to be conducted for 50 marks each. The average of the two tests are taken for computation of CIE on a scale of 50.

Table: Distribution of weightage for CIE & SEE of Regular courses.

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO54.**1**	3	2	2	-	-	-	-	-	1	1	-	3	3	-	-
CO54.**2**	3	-	-	-	3	2	2	-	1	-	-	3	3	-	-
CO54.**3**	3	-	-	-	3	-	-	-	3	3	-	3	3	-	-
Average	3	2	2		3	2	2		3	3		3	3	-	-

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: Mechanical Vibrations

Course Code	22MED55A	CIE Marks	50
Hours/Week (L: T: P)	3: 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Engineering Mechanics

Course Objectives: This course will enable the students to:

CLO1	Understand the fundamentals of Vibration Theory.
CLO2	Mathematically model real-world mechanical vibration problems.
CLO3	Determine natural frequencies of undamped, damped and forced vibrating systems of one, degree freedom systems.
CLO4	Learn the process of vibration measurements and control.
CLO5	Understand the fundamental principles of maintenance and condition monitoring techniques.

Content	No. of Hours/ RBT levels
Module 1 **Undamped (Single Degree of Freedom) Free Vibrations** **Introduction to Vibrations, Types of vibrations,** Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and Transverse vibrations, Effect of mass of spring and Problems.	**8** **L1,L2,L3**
Module 2 **Damped free vibrations:** Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.	**8** **L1,L2,L3**
Module 3 **Forced Vibrations:** Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility.	**8** **L1,L2,L3**
Module 4 **Vibration Measuring Instruments and Whirling of shafts: Seismic Instruments** Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.	**8** **L1,L2,L3**
Module 5 **Modal analysis and Condition Monitoring:** Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis.	**8** **L1,L2,L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO55A.1	Derive mathematical models for simple vibration systems.
CO55A.2	Determine equation of motion, natural frequency, damping factor, logarithmic decrement of damped free vibration (SDOF) systems.
CO55A.3	Analyse and solve problems of forced vibrations involving frequency response curves, phase angle plots, vibration isolation and transmissibility.
CO55A.4	Describe seismic instrument, frequency measuring instruments, critical speed of shaft with and without damping and solve problems.
CO55A.5	To impart basic knowledge and importance on Vibration Based Condition Monitoring in Engineering Fields

Textbooks:

1. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4th edition, 2003.
2. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & Company, 3rdedition, 2006..

Reference books:

1. Theory of Vibration with Applications, W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. Mechanical Vibrations: S. Graham Kelly, Schaum's outline Series,Tata McGraw Hill, Special Indian Edition, 2007.
3. Theory and Practice of Mechanical Vibrations: J. S. Rao &K.Gupta, New Age International Publications, New Delhi, 2001.
4. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros, 6th edition, 1996

E-Books / Web References

1. https://www.youtube.com/watch?v=-WCBkuGTtz8&list=PLMgYkY7H7uuScB-VW9d81PW-kyWp0tY05 (complete videos on vibrations – all syllabus)
2. https://www.math.nyu.edu/faculty/childres/vibes.pdf
3. http://vdol.mae.ufl.edu/CourseNotes/EML4220/vibrations.pdf

MOOCs

1. https://nptel.ac.in/courses/112107212
2 https://nptel.ac.in/courses/112107087

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module**.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks.

Some possible AATs:
Assignments/ group activity / any other.

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Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-2	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO55A.1	2	2	1	1	-	1	1	-	-	-	-	1	1	-	-
CO55A.2	2	2	1	1	-	1	1	-	-	-	-	1	1	-	-
CO55A.3	2	2	1	1	-	1	1	-	-	-	-	1	1	-	-
CO55A.4	2	2	1	1	-	1	1	-	-	-	-	1	1	-	-
CO55A.5	2	2	1	1	-	1	1	-	-	-	-	1	1	-	-
Average															

Low - 1: Medium - 2: High – 3

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SEMESTER – V

PRODUCT LIFE CYCLE MANAGEMENT

Course Code	22MED55B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	To familiarize with various strategies of PLM
CLO2	Understand the concept of product design and simulation.
CLO3	Develop New product development, product structure and supporting systems
CLO4	Interpret the technology forecasting and product innovation and development in business processes.
CLO5	Understand product building and Product Configuration.

Content	No. of Hours/ RBT levels
Module 1 **INTRODUCTION TO PLM AND PDM:** Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, and implementation of PDM systems.	**08 Hours / L2**
Module 2 **PRODUCT DESIGN:** Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product	**08 Hours / L2**
Module 3 **PRODUCT DEVELOPMENT:** New Product Development, Structuring new product development, building a decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**08 Hours / L2**
Module 4 **TECHNOLOGY FORECASTING:** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.	**08 Hours / L2**

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Module 5	
PRODUCT BUILDING AND STRUCTURES: Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.	**08 Hours / L2**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO55B.1	Understand the need, benefits, components, phases, feasibility and strategies of PLM.
CO55B.2	Describe product design, organization, decomposition, design for 'X' and design central development model.
CO55B.3	Explain new product development, structuring, estimating market opportunities, launching and tracking of new product.
CO55B.4	Interpret the technology forecasting, product innovation and development in the business processes.
CO55B.5	Describe the virtual product development tools for product building and product configuration.

Textbooks:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference books:

1. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer,Dreamtech,3-540-25731-
2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

E-Books / Web References

1. https://onlinecourses.swayam2.ac.in/imb19_mg01/preview
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/product-lifecycle-management

MOOCs

1. https://nptel.ac.in/courses/110104084
2. https://nptel.ac.in/courses/112107217

Scheme of Examination: (Theory courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

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Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is conducted and evaluated for 10 marks.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table below.

Table : Distribution of weightage for CIE & SEE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO55B.1	3	1								1		1			
CO55B.2	3	1								1		1			
CO55B.3	3	1								1		1			
CO55B.4	3	1								1		1			
CO55B.5	3	1								1		1			
Average	**3**	**1**								**1**		**1**			

Low - 1: Medium - 2: High - 3

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SEMESTER – V

Course: Supply Chain Management and Introduction to SAP

Course Code	22MED55C	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management and Entrepreneurship

Course Objectives:

CLO1	Understand the stages, decision phases and process views in supply chain management
CLO2	Identify the major drivers of supply chain performance.
CLO3	Describe inventory management, transportation and the key factors considered in designing a distribution network.
CLO4	Develop a frame work for making network design decisions and coordination in supply chain.
CLO5	Discuss the importance of supply chain restructuring and the future of IT in supply chain management.

Content	No. of Hours/ RBT levels
Module 1 **Introduction: Supply Chain –** Fundamentals –Evolution Role in Economy – Importance Decision Phases –Supplier Manufacturer – Customer chain - Enablers/Drivers of Supply Chain Performance. Supply chain strategy Supply Chain Performance Measures. **Strategic Sourcing Outsourcing** – Make Vs buy Identifying core processes Market Vs Hierarchy Make Vs buy continuum – Sourcing strategy Supplier Selection and Contract Negotiation.	**8 Hours / L1, L2, L3**
Module 2 **Warehouse Management Stores management –** stores systems and procedures in-coming materials control stores accounting and stock verification Obsolete, surplus and scrap value analysis material handling transportation and traffic management operational efficiency productivity cost effectiveness performance measurement. **Supply Chain Network Distribution Network Design –** Role Factors Influencing Options, Value Addition – Distribution Strategies Models for Facility Location and Capacity allocation. Distribution Center Location Models.	**8 Hours / L1, L2, L3**
Module 3 **Supply Chain Network optimization models.** Impact of uncertainty on Network Design Network Design, decisions using Decision trees. Planning Demand, multiple item - multiple location inventory management. Pricing and Revenue Management.	**8 Hours / L1, L2, L3**
Module 4 **Current Trends: Supply Chain Integration -** Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating	**8 Hours / L1, L2, L3**

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the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain Agile Supply Chain - Reverse Supply chain. Future of IT in supply chain - EBusiness in supply chain.	
Module 5 **Introduction to SAP:** SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO55C.1	Understand the fundamentals and scope of Supply Chain management.
CO55C.2	Build and manage a competitive supply chain using strategies, models, techniques and information technology.
CO55C.3	Identify the role of network design and Plan the demand, inventory and supply and optimize supply chain network.
CO55C.4	Indentify the recent trends for effective supply chain management and the impact of IT in supply chain.
CO55C.5	Apply the SAP basics in industries for effective material, procurement and inventory management.

Textbooks:

1. **Sunil Chopra and Peter Meindl**, Supply Chain Management, 3rd Edition, Pearson Education 2007.
2. **Janat Shah**, Supply Chain Management, Text and Cases, Pearson Education 2009.

Reference books:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi.
2. Total Supply Chain Management by Ron Basu, J. Nevan Wright.
3. Supply Chain Management, Chopra, Pearson
4. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill.

E-Books / Web References

1. **https://onlinecourses.nptel.ac.in/noc21_mg45/preview**
2. **https://nptel.ac.in/courses/110106045**
3. **https://www.udemy.com/course/sapmmtraining/**
4. **https://www.udemy.com/course/saps4hanammsourcingandprocurement/**
5. **https://nptel.ac.in/courses/110105095.**

NPTEL / MOOC

1. NPTEL Course: "Global Supply Chain Management" https://nptel.ac.in/courses/110108056
2. NPTEL Course: "Operations and Supply Chain Management " https://nptel.ac.in/courses/110106045

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3. NPTEL Course: "Modelling and Analytics for Supply Chain Management''
   https://nptel.ac.in/courses/110105141

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO55C.1	1								2	2	3	1			
CO55C.2	1								2	2	3	1			
CO55C.3	1								2	2	3	1			
CO55C.4	1								2	2	3	1			
CO55C.5	1								2	2	3	1			
Average	**1**								**2**	**2**	**3**	**1**			

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: Automation in Manufacturing

Course Code	22MED55D	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	Explain the basics of productions, automation system and manufacturing operations.
CLO2	Solve the simple problems on mathematical model.
CLO3	Explain CAPP and MRP system and analyze the AGVS.
CLO4	Understand the inspection technologies and shop floor control.
CLO5	Explain the modern trends in additive manufacturing and automated factory

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Production system facilities, Manufacturing support systems, Automation in production systems, Automation principles & strategies Manufacturing Operations: Manufacturing operations, Product/production relationship, Production concepts and Mathematical models &costs of manufacturing operations. Problems on mathematical models	**8 Hours / L1, L2, L3**
Module 2 **Line Balancing:** Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge's and Wester's method, and ranked positional weights method, computerized line balancing methods. Automated Assembly System: Design for automated assembly, types of automated assembly system, Parts feeding devices, Analysis of single and multi-station assembly machines.	**8 Hours / L1, L2, L3**
Module 3 **Computerized Manufacture Planning and AGVS:** Computer aided process planning (CAPP), Retrieval and Generative systems, and benefits of CAPP. Material requirement planning, Inputs to MRP system, working of MRP, Outputs and benefits. Automated Guided Vehicles System: Applications, Guidance and routing, Industrial Robotics: Definition, Robot anatomy, Joints and links, Robot configurations, Robot control systems, Accuracy and repeatability, End effectors, Sensors in robotics. Industrial robot applications: Material handling, Processing, assembly and inspection.	**8 Hours / L1, L2, L3**
Module 4 **Inspection Technologies:** Automated inspection, coordinate measuring machines construction, Operation &programming, Software, application &benefits, Flexible inspection system, Inspection probes on machine tools, Machine vision, Optical inspection techniques & Noncontact Non optical inspection technologies. Shop Floor Control and Automatic Identification Techniques: Shop floor control, Factory data collection system, Automatic identification methods, Bar code technology, Automatic data collection systems. An Introduction to QR Code Technology.	**8 Hours / L1, L2, L3**

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Module 5	
Additive Manufacturing Systems: Basic principles of additive manufacturing, Slicing CAD models for AM, Advantages and limitations of AM technologies, Recent trends in manufacturing, Hybrid manufacturing. Future of Automated Factory: Trends in manufacturing, the future automated factory, Human workers in future automated factory, Social impact	**8 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO55D.1	Explain the basics of productions, automation system and manufacturing operations. Solve the simple problems on mathematical model
CO55D.2	Explain CAPP and MRP system and analyze the AGVS.
CO55D.3	Understand the inspection technologies and shop floor control..
CO55D.4	Explain the modern trends in additive manufacturing and automated factory.

Textbooks:

1. Automation, Production Systems and Computer Integrated Manufacturing, by Mikell P Groover, 3rd Edition, 2009, PHI Learning.
2. Automation, Production Systems and Computer Integrated Manufacturing, by Mikell P Groover, 1999, Prentice Hall of India.
3. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata Mc Graw Hill
4. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker 98
5. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011

Reference books:

1. Systems Approach to Computer Integrated Design and Manufacturing by Dr. Nanua Singh,Wiley, 1996
2. CAD/CAM/CIM P. Radhakrishnan, S. Subramanyan, U. Raju, New Age International Publication Revised Third Edition 2007. Delhi.

E-Books / Web References

1. http://lavalle.pl/vr/book.html
2. https://nptel.ac.in/courses/106/106/106106138/
3. https://www.coursera.org/learn/introduction-virtual-reality**.**

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks.

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Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO55D.1	1								2	2	3	1			
CO55D.2	1								2	2	3	1			
CO55D.3	1								2	2	3	1			
CO55D.4	1								2	2	3	1			
Average	**1**								**2**	**2**	**3**	**1**			

Low - 1: Medium - 2: High – 3

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SEMESTER – V

Course: Mini-Project

Course Code	22MEDP56	CIE Marks	50
Hours/Week (L: T: P)	0: 0: 4	SEE Marks	50
No. of Credits	2	Examination Hours	

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-Project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini-Project shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batchmates.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review-1	-	100
	Review-2	100	
Grand Total			100

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SEMESTER – V
Course: Research Methodology and IPR

Course Code	22RMIK57	CIE Marks	50
Hours/Week (L: T: P)	2 : 2 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: To enable students to apply the knowledge of Research Methodology in broad domain of Mechanical Engineering by making them to learn:

CLO1	To make the student understand the foundations of Research and problem solution
CLO2	Knowledge in Research design, Qualitative and Quantitative Research
CLO3	Knowledge to formulate and derive static and dynamic aero elastic equations of motion.
CL04	To understand the different types of IPR

Content	No. of Hours/ RBT levels
Module 1 **RESEARCH METHODOLOGY:** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. **DEFINING THE RESEARCH PROBLEM:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration	**08 Hours/ L3**
Module 2 **REVIEWING THE LITERATURE:** Place of the literature review in research, bringing clarity and focus to research problem, improving research methodology, broadening knowledge base in research area, enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, developing a theoretical framework, developing a conceptual framework, writing about the literature reviewed. **RESEARCH DESIGN**: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.	**08 Hours/ L3**
Module 3 **DESIGN OF SAMPLE SURVEYS:** Design of Sampling: Introduction, Sample Design, Sampling and Non-Sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **MEASUREMENT AND SCALING:** Qualitative and Quantitative Data, **DATA COLLECTION:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	**08 Hours/ L3**

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Module 4 **TESTING OF HYPOTHESES:** Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. **INTERPRETATION AND REPORT WRITING:** Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**08 Hours/ L3**
Module 5 **INTELLECTUAL PROPERTY**: Principles of IPR, Kinds of IPR, Patent- Concepts, Novelty, Utility Inventiveness/Non-obviousness, Procedure for granting and obtaining patents; Copyright- conditions for grant of copyright, Copyright in Literary, Dramatic and Musical ,Works, Sound Recording, Cinematograph Films, Copyright in Computer Programme, Author Special Rights, Right of Broadcasting and performers, Trademark Law and Practices - Procedure of registration of trademark; Emerging Issues and Challenges; Few Future Aspects of Intellectual Property Rights;	**08 Hours/ L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Understand the research problem by literature review to solve problems
CO2	Develop skills in qualitative and quantitative data analysis and presentation.
CO3	Develop advanced critical thinking skills.
CO4	Understand to write the report writing and awareness about IPR

Textbooks:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
4. Lionel Bently., Brad Sherman-Intellectual Property Law, 3rd Edition

Reference books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

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3. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
4. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

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SEMESTER – V

Course: Environmental Studies

Course Code	22CIVK58	CIE Marks	50
Hours/Week (L: T: P)	2 : 0 : 0	SEE Marks	50
No. of Credits	2	Examination Hours	03

Course Objectives: Students will be taught:

CLO1	To understand ecosystem functions and 17 SDG's for sustainable development
CLO2	To understand advanced energy systems and natural resource management.
CLO3	To understand about pollution and waste management solutions and laws
CLO4	To understand global environmental issues, related policies and solutions through case studies
CLO5	To understand key environmental legislation related to water, air, waste and environmental protection.

Content	No. of Hours/ RBT levels
Module 1 – Ecosystem and Sustainability Ecosystems (Structure and Function): Forest, Desert, Wetlands, River, Oceanic and Lake. Sustainability: 17 SDGs-History, targets, implementation, Capacity Development	**6 Hours L2**
Module 2 - Natural Resource Management Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind. Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining - case studies and Carbon Trading	**6 Hours L2**
Module 3 – Environmental Pollution & Waste Management Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution. Waste Management: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge	**6 Hours L2**
Module 4 - Global Environmental Issues Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology	**6 Hours L2**
Module 5 – Environmental Legislation Environmental Legislation: Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste management Rule - 2022, Biomedical Waste management- 2016	**6 Hours L2**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

22CIVK58.1	**Analyze** ecosystem dynamics to formulate strategies for addressing sustainability challenges and implementing the SDGs.
22CIVK58.2	**Evaluate** energy technologies to design effective resource management strategies.
22CIVK58.3	**Evaluate** the impacts of pollution to develop effective waste management strategies.
22CIVK58.4	**Evaluate** global environmental issues to design solutions for sustainable management.
22CIVK58.5	**Interpret** environmental laws and regulations for sustainable management practices.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018

References:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of environmental science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental studies, university of science press 1st edition

Web Reference:

https://www.hzu.edu.in/bed/E%20V%20S.pdf
https://onlinecourses.nptel.ac.in/noc23_hs155/preview
https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination:

Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three test marks will be added to test component. CIE is executed by way of two quizzes/Alternate Assessment Tools(AAT's), some possible AAT's: Seminar/ assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

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Typical Evaluation pattern is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	40	**50**
	CIE Test-2	40	
	CIE Test-3	40	
	Average of CIE	**40**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	**Semester End Examination**	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
22CIVK58.1	2					1	1	1							3
22CIVK58.2	2	2	2			1	3	1							3
22CIVK58.3		2	2	2		1	3	1							2
22CIVK58.4		2	2	2		1	3	1							2
22CIVK58.5	1	2	2	2		1	2	1							2
Average	**1.67**	**2**	**2**	**2**		**1**	**2.4**	**1**							**2.4**

Low-1: Medium-2: High-3

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VI SEMESTER

SYLLABUS

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SEMESTER – VI
Course: Finite Element Methods

Course Code	22MED61	CIE Marks	50
Hours/Week (L: T: P)	2:2:0	SEE Marks	50
No. of Credits	3	Examination Hours	3

Prerequisites: Basic Mathematics, Strength of Materials, Mechanical Vibrations

Course Objectives: The students will be taught to:

CLO1	Learn basic concepts of the Finite Element Method (FEM) and elasticity theory for engineering problems.
CLO2	Use polynomial interpolation and element formulations to solve engineering problems in finite element analysis.
CLO3	Use stiffness matrices for bars, trusses, and beams, solve problems with different loads, and analyze 1-D heat transfer.
CLO4	Apply Lagrange's interpolation methods and numerical integration techniques in finite element analysis.
CLO5	Use key numerical methods to solve engineering problems.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to FEM:** Introduction to FEM, Engineering applications, advantages, General steps in FEM, Element types, Convergence criteria, Co-ordinate systems, Commercial packages, pre-processor, solver and post processor. **Principles of Elasticity:** Strain-displacement relations, Stress-strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions. **Introduction to Numerical Methods:** Potential energy method, Rayleigh Ritz method and Galerkin's method applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.	**08 Hours / L1, L2, L3**
Module 2 **One Dimensional Element:** Formulation of a linear bar element, Shape Functions-Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary condition, Elimination method. Numerical Problems on straight and stepped bars. (Numericals with 2 elements only).	**08 Hours / L1, L2, L3**
Module 3 **Trusses:** Formulation plane trusses element, Stiffness matrix of truss element (No derivation), Numericals on point load. (Numericals with maximum of three elements), **Beams:** Formulation beam element, Hermite shape functions (No derivation), stiffness matrix and load vector due to UDL and UVL (No derivations), Numericals on beams carrying concentrated, UDL, UVL and couples. (Problems with 2 elements only).	**08 Hours / L1, L2, L3**
Module 4 **Two Dimensional Elements:** Lagrangian method for formulation of triangular and quadrilateral elements, Displacement models and shape functions for linear and higher	**08 Hours / L1, L2, L3**

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order elements, Serendipity elements, Iso-parametric, Sub-parametric, Super parametric elements, Pascal triangle. (No numerical problems) **Numerical integration:** Gauss quadrature one point, two-point and three-point formulae. (Simple Numericals)	
Module 5 **Dynamic considerations:** Formulation for point mass and distributed masses, Consistent mass matrices for 1D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars. **Heat Transfer Problems:** Steady state heat transfer, 1D heat conduction governing equation, boundary conditions, Numerical problems on composite wall, 1D heat transfer in thin fins.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO61.1	Evaluate different element types in FEM and their impacts and integrate advanced elasticity concepts to derive and solve practical engineering challenges
CO61.2	Analyze simplex, complex, and multiplex elements, and iso-, sub-, and super-parametric elements
CO61.3	Formulate and apply stiffness matrices for bars, trusses, and beams, solve numerical problems involving axial loads and various loading conditions, and analyze 1-D steady-state heat transfer in different scenarios
CO61.4	Utilize Lagrange's interpolation for higher-order elements, including quadratic bar elements, CST elements, and quad elements, and apply Gauss quadrature methods for numerical integration with one, two, and three points
CO61.5	Apply the Potential Energy Method, Rayleigh-Ritz Method, and Galerkin's Method to solve engineering problems through simple numerical examples

Textbooks:

1. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.
2. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001

Reference books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition. Bathe K. J. Finite Elements Procedures, PHI. 2.
2. Cook R. D., et al. "Concept sand Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

E-Books / Web References

1. 1.https://www.youtube.com/watch?v=C6X9Ry02mPU
2. 2.https://www.youtube.com/watch?v=GHjopp47vvQ
3. 3.https://www.youtube.com/watch?v=MC8pTORcKJM

MOOCs : https://www.youtube.com/watch?v=UOp6JEiJctA-(NPTEL)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module. **Note:** The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular

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laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for integrated courses is shown in the Table below

Table: Distribution of weightage for CIE & SEE of Integrated courses

	Component	**Marks**	**Total Marks**
CIE	CIE Test-1	**30**	**50**
	CIE Test-2	**30**	
	CIE Test-3	**30**	
	Quiz /AAT	**20**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO61.1	3	2	2		3	1			1	2		2	2		
CO61.2	3	2	2		3	1			1	2		2	2		
CO61.3	3	2	2		3	1			1	2		2	2		
CO61.4	3	2	2		3	1			1	2		2	2		
CO61.5	3	2	2		3	1			1	2		2	2		
CO61	3	2	2		3	1			1	2		2	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: HEAT TRANSFER

Course Code	22MED62	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 2	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites:

Course Objectives: students will be able to

CLO1	Understand the types of heat transfer applied to engineering systems
CLO2	Learn various engineering correlations of heat transfer analysis and apply to thermal design of engineering components and systems.
CLO3	Evaluate the heat transfer process parameters used in solving engineering problems related to conduction, convection and radiation
CLO4	Understand and apply the boundary layer concept to forced and free convection problems
CLO5	Review of boiling and condensation concepts and hence use in design of heat exchangers

Content	No. of Hours/ RBT levels
Module 1 **Introductory Concepts and definition:** Review of basics of Modes of Heat Transfer. **Conduction-Basic Equations:** General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds. **One dimensional Steady state conduction with and without heat generation:** Steady state conduction in slab, cylinder and sphere with engineering applications. (No derivations) **Steady state conduction:** Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications. (No derivations)	**10 Hours / L1, L2, L3**
Module 2 **Extended surfaces;** Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications. (No derivations) **One dimensional Transient conduction:** Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; Discussion on engineering applications.	**10 Hours / L1, L2, L3**
Module 3 **Numerical Analysis of Heat Conduction:** Introduction, one-dimensional steady conduction and one-Dimensional unsteady conduction, boundary conditions, and solution methods.	**10 Hours / L1, L2, L3**

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Radiation Heat transfer: Review of basic laws of thermal radiation, Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.	
Module 4 **Concepts and Basic Relations in Boundary layers**: Flow over a flat plate Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient. **Forced Convection:** Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct. **Free or Natural Convection:** Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.	**10 Hours / L1, L2, L3**
Module 5 **Boiling and Condensation**; Pool boiling regimes. Basics of Film and dropwise condensation, Use of correlations for film and dropwise condensation on tubes. **Heat Exchangers:** Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers (NO derivations).	**10 Hours / L1, L2, L3**

Exercise Number	Experiment	No. of Hours/ RBT Levels
I, II	Determination of Thermal Conductivity of a Metal Rod and overall heat transfer coefficient of composite wall	02 Hours/ L3
III, IV	Determination of Effectiveness of a Metallic Pin fin and Experiment on Transient Conduction Heat Transfer	02Hours/ L3
V, VI	Determination of Emissivity of a Surface and Stefen Boltzman constant.	02 Hours/ L3
VII, VIII	Determination of Heat Transfer Coefficient in a free Convection on a cylinder and Forced Convention Flow through a Pipe.	02 Hours/ L3
IX, X	Determination of LMDT and Effectiveness in a Parallel and counter Flow Heat Exchangers.	02 Hours/ L3
XI, XII, XIII	Experiments on Boiling of Liquid and Condensation of Vapour. Performance Test on Vapour Compression Refrigeration and Vapour Compression Air – Conditioner.	02 Hours/L3

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO62.1	Understand and compute the conduction heat transfer across different geometries
CO62.2	Predict and quantify the thermal energy transfer in steady state and transient situations by employing various charts and correlation tables.
CO62.3	Analyze heat conduction numerically and Review of basic concepts and basic laws of radiation, shape factors and radiation exchange between two finite bodies.
CO62.4	Apply the boundary layer concept to analyze the flow of heat through bodies with varied cross sections with respect to forced and free convection.
CO62.5	Analyze and evaluate heat transfer rates for problems involving phase transformation like condensation, evaporation and design of heat exchangers

Textbooks:

1. **Yunus A. Cengel, Afshin J Ghajar –** Heat and Mass Transfer, Fundamentals and Applications, Sixth edition, Tata Mc Graw Hill.
2. **Er.R.K. Rajput,** A textbook of Heat and Mass Transfer, Revised Edition, 2019, S Chand and Company Ltd.

Reference books:

1. **Incropera, F. P. and De Witt,** Fundamentals of Heat and Mass Transfer, D. P., 5th Edition, John Wiley and Sons, New York, 2006.
2. **M. Necati Ozisik,** Heat Transfer, A Basic Approach, McGraw Hill, New York, 2005.
3. **Holman, J. P,** Heat Transfer, 9th Edition, Tata McGraw Hill, New York, 2008.

E-Books / Web References

1. https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGlWDQdpQzkY9
2. https://www.kochheattransfer.com/products/twisted-tube-bundle-technology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OHa8PBzHX1Yo_DKQcheV46aZxtDRvDIhCe1Gfpr5obDMLoaArSXEALw_wcB.
3. https://www.hightempfurnaces.com/

MOOCs

1. NPTEL Course: "Heat and Mass Transfer" (https://nptel.ac.in/courses/112101097)
2. MOOC Course: "Heat and Mass Transfer" (https://www.coursera.org)
3. Free Video Lectures: "Heat and Mass transfer", (https://freevideolectures.com/course/3533/convective-heat-transfer)

Scheme of Examination:
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE): Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component. CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.
Some possible AATs:

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Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO62.1	3	2	1		1		1			1		1		1	
CO62.2	3	2	1		1		1			1		1		1	
CO62.3	3	2	1		1		1			1		1		1	
CO62.4	3	2	1		1		1			1		1		1	
CO62.5	3	2	1		1		1			1		1		1	
Average	**3**	**2**	**1**		**1**		**1**			**1**		**1**		**1**	

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: DESIGN OF TRANSMISSION ELEMENTS

Course Code	22MED63A	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Strength of material

Course Objectives: The students will be taught:

CO1	The analysis and design of mechanical springs
CO2	The design of power transmission elements like belts, ropes and chains.
CO3	The analysis and design clutches and brakes
CO4	The analysis and design spur and helical gears
CO5	The analysis and design bevel and worm gears

Content	No. of Hours/ RBT levels
Module 1 **Helical Springs:** Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs. **Leaf Springs**: Stresses in leaf springs, equalized stresses, nipping of leaf springs. Design of leaf springs.	**10 Hours / L1, L2, L3**
Module 2 **Belts:** Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts- length & cross section from manufacturers' catalogues. **Wire ropes and Chains**: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes , Chains: Types of chains, Selection of roller chains.	**10 Hours / L1, L2, L3**
Module 3 **Design of Clutches:** Necessity of a clutch in an automobile, types of clutch, friction materials and its properties. Design of cone clutch, single plate and multi-plate clutches based on uniform pressure and uniform wear theories. **Design of Brakes:** Different types of brakes, Concept of self-locking of brakes. Practical examples, Design of block brakes, band brakes.	**10 Hours / L1, L2, L3**
Module 4 **Gear drives:** Classification of gears, materials, standard systems of gear tooth **Spur Gears:** Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. **Helical Gears:** Definitions, transverse and normal module, design based on strength, dynamic load and wear.	**10 Hours / L1, L2, L3**
Module 5 **Bevel Gears:** Definitions, Types of bevel gears, design based on strength, dynamic load and wear. **Worm Gears**: Definitions, materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	**10 Hours / L1, L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO63A.1	Calculate the stresses in helical springs with circular and non-circular cross-sections and apply principles to the design and stress analysis of leaf springs.
CO63A.2	Determine the suitable materials, design specifications, and performance parameters for flat and V belts, wire ropes, and chains, including the calculation of power ratings, slip and creep effects, and stress analysis.
CO63A.3	Design various types of clutches and brakes while considering friction materials, self-locking concepts for effective power transmission and braking performance in automotive applications.
CO63A.4	Design spur and helical gears based on strength, dynamic load, and wear, using Lewis equation and form factors for spur gears and helical gears.
CO63A.5	Design bevel gears and worm gears, selecting appropriate materials and applying design principles to ensure strength, minimize dynamic loads and wear, and optimize the efficiency of worm gear drives.

TEXT BOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles R.Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HAND BOOK:

1. **Design Data Hand Books, Volume 1 and 2,** K. Lingaiah, McGraw Hill, 2nd Ed.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. **Design of Machine Elements,** M. F. Spotts, T. E. Shoup, L. E Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. **Machine Design,** Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

WEB/ONLINE REFERENCES

1. www.nptel.ac.in

MOOCs

1. NPTEL Course: "Design of Machine Elements" http://https://nptel.ac.in/courses/112/107/112107146/#
2. NPTEL Course: "Strength of Materials" (https://onlinecourses.nptel.ac.in/)
3. MOOC Course: "Machine Design", (https://www.coursera.org/courses?query=mechanics%20of%20materials)
4. Free Video Lectures: "Design of Machine Elements", (https://freevideolectures.com/course/96/)

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced

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to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.
Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity / Projects

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO63A.1	3	2	2	1		1	1			1		2	2		
CO63A.2	3	2	2	1		1	1			1		2	2		
CO63A.3	3	2	2	1		1	1			1		2	2		
CO63A.4	3	2	2	1		1	1			1		2	2		
CO63A.5	3	2	2	1		1	1			1		2	2		
Average	**3**	**2**	**2**	**1**		**1**	**1**			**1**		**2**	**2**		

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: REFRIGERATION AND AIR CONDITIONING

Course Code	22MED63B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Thermodynamics, heat transfer

Course Objectives: The students will be taught:

CLO1	The basic refrigeration and air-conditioning systems.
CLO2	To analyze simple vapour compression system and vapour absorption systems
CLO3	The usage of psychrometric charts and estimation of cooling loads.
CLO4	The applications of refrigeration and air-conditioning and ducting calculations

Content	No. of Hours/ RBT levels
Module 1 **Vapour Compression Refrigeration System:** Review of thermodynamic principles of refrigeration, classification of refrigerants, desirable properties of refrigerants, leak detection, lubricants, Bootstrap air-cooling system with and without evaporative cooling, Performance of simple vapour compression system, single and multistage compression system, multi-evaporator system, simple numerical on VCR system	**08 Hours / L3**
Module 2 **Absorption Refrigeration System** Basic absorption system, COP, Refrigerator, Advantage and limitation over vapour compression system, Binary mixtures, Temperature concentration diagram, Aqua ammonia system, LiBr Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration, Air Refrigeration cycles, simple numericals on VAR system.	**08 Hours / L3**
Module 3 **Refrigeration Equipment and Control** Main system components, Compressor types, principle of operation, specifications, condenser – types and specification, selection, Evaporator types, Refrigeration controls, safety devices, defrosting introduction and its methods.	**08 Hours / L3**
Module 4 **Psychrometric Charts and Cooling Loads:** Psychometric processes, Use of Charts, sensible heating and cooling, humidification and dehumidification, adiabatic mixing of fluids, evaporative cooling. Cooling load and heating load estimation, solar radiation, heat gain, factors considered in load estimation, design of cold storage simple numericals on using psychrometric chart.	**08 Hours / L3**

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Module 5 **Introduction to HVAC System** Main parts of air conditioning equipment, classification of air conditioning systems, Central, zoned, unitary, summer and winter air conditioning. General aspects of duct system, pressure and pressure loss in ducts, duct design, Air- distribution system, simple numericals, Principles of ice production, food preservation, milk chilling plant.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO63B.1	Analyze the principles of vapor compression refrigeration systems by applying advanced principles of refrigeration.
CO63B.2	Evaluate and innovate the performance of vapor absorption refrigeration systems to enhance efficiency and application in various contexts.
CO63B.3	Implement advanced control strategies for various components of refrigeration equipment to improve system reliability and performance.
CO63B.4	Apply advanced psychrometric analysis techniques to optimize air conditioning processes for improved indoor air quality and energy efficiency.
CO63B.5	Evaluate various air conditioning systems and their applications to meet specific environmental and operational requirements effectively.

Textbooks:

1. Refrigeration and Air-conditioning, **Arora. C.P**., 3rd Edition, 2009 , Tata McGraw Hill, ISBN: 978007008390-5
2. A Textbook of Refrigeration and Air-Conditioning, **Rajput. R.K**., 2019, S.K. Kataria and sons, New Delhi, ISBN: 978-93-5014-255-4

Reference books:

1. Refrigeration and Air conditioning, Stoecker. W.F., Jones. J.W, 2nd Edition, 1982, Tata McGraw Hill, ISBN: 0070616191
2. Principles of Refrigeration, Dossat. R.J. Horan. T.J., 5th Edition, 2006, Prentice Hall, ISBN: 013027270
3. "Principles of Air Conditioning", V Paul Lang, Delmar Cengage Learning, 1995.
4. "Refrigeration & Air Conditioning Data Hand book" , Manohar Prasad , New Age, International, 2nd Edition. 2013.

E-Books / Web References

1. https://archive.nptel.ac.in/courses/112/107/112107208/
2. https://freevideolectures.com/course/2372/refrigeration-and-air-conditioning

MOOC's:

- https://onlinecourses.nptel.ac.in/noc19_me58/preview

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module

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carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**
The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO63B.1	**3**	2	1	1	2	1	1				1	1		1	
CO63B.2	3	2	1	1	2	1	1				1	1		1	
CO63B.3	3	2	1	2	1	1	1				1	1		1	
CO63B.4	3	2	1	2	1	1	1				1	1		1	
CO63B.5	3	2	1	1	1	1	1				1	1		1	
Average	**3**	**2**	**1**	**2**	**2**	**1**	**1**				**1**	**1**		**1**	

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: Project & Operations Management

Course Code	22MED63C	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to,

CLO1	To instill Project Management principles and practices to create/develop a unique product, a unique service or capability to perform a service, unique result, such as an outcome or document and/or a unique combination of one or more products, services or results.
CLO2	To inculcate the S.M.A.R.T deliverables of a project and evaluate the impact of these deliverables on the states of nature viz. economic, material, social, and environmental.
CLO3	To elucidate the benefits of Project Management and its applications on business value creation comprising tangible (Monetary assets, Stakeholder equity, Utilities and Market share etc.) and intangible elements (Strategic alignment, Goodwill and Brand recognition etc.).

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Project Management:** Understanding Project Management, Defining the Project Manager's Role, Defining the functional Manager's role, the project manager as the planning agent, Project Sponsor Interface, project Champions, Project Driven v/s Non-project Driven Organizations. Classifications of Projects, Differing views of Project Management, Concurrent Engineering: A project Management approach, informal Project Management Product v/s Project management, Project Life cycles, Many faces of failure.	**10 Hours /L3**
Module 2 **Planning:** Phases of Project Life Cycle: Initiating Process (Engineering Quote Process, The Project Award, Project with a Kick-off), Planning Process (Information Sharing, Development & Updating in Project Plan), Executing Process, Monitoring and Controlling Process and Closing Process. Scope Management: Development of Work Breakdown Structure (WBS) and Resources Management. Estimation of WBS effort.	**10 Hours /L3**
Module 3 **Network Scheduling Techniques:** Network Fundamentals, Slack time, Network planning, estimating total project time, Total PERT/CPM planning, Crashing of Networks, PERT/CPM Numericals.	**10 Hours /L3**
Module 4 **Project Development Models:** Introduction and Comparison between Waterfall Methodology and Agile Methodology. Waterfall Model: Stages of Waterfall methodology (Requirements, Design, Implementation, verification or testing and Deployment &	**10 Hours /L3**

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Maintenance), Prominent Uses of Waterfall Methodology, Advantages and Disadvantages of Waterfall Methodology. **Agile Methodology:** Overview, Agile Manifesto, 3C's of Agile (Card, Conversation and Confirmation), Benefits of Agile Model.	
Module 5 **Forecasting:** Nature and Use of Forecast, Forecasting Models and methods – Selection of Forecasting Techniques, measures of Forecasting accuracy, simple moving average, weighted moving average, double moving average, simple exponential smoothening, adjusted exponential smoothening, Linear regression method. **Inventory Control**: Inventory Decisions, Costs, Inventory Models.	**10 Hours /L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to

CO63C.1	Recognize the significance of Project Management in complex business setups and describe an organized flow structure for effective accomplishment of predetermined objectives of organization.
CO63C.2	Understand the Project life cycle processes and construct an appropriate action plan for optimizing resources of the underlying project deliverables.
CO63C.3	Apply the knowledge of the construction of networks and the estimation of the time of completion of the project
CO63C.4	Distinctively elaborate the difference between the Waterfall Methodology and Agile Methodology and apply the appropriate Project development models
CO63C.5	Understand the costs and models of forecasting and inventory techniques.

Textbooks:

1. **Harold Kerzner:** Project Management - A Systems Approach to Planning, Scheduling, and Controlling, 10th edition.
2. A Guide to the Project Management Body of Knowledge – Project Management Institute.
3. **Kalpesh Asher:** Project Management and Agile Essentials – A Practical Self-Study Guide, Vibrant Publishers.
4. Pannerselvam, Production and Operations Management – Third Edition, PHI

Reference books:

1. **Mark C. Layton, Steven J. Ostermiller**: Agile Project Management for Dummies.
2. **Prasanna Chandra:** Project Management – Planning & Control, TMH.

E-Books / Web References

1. https://opentextbc.ca/projectmanagement/
2. https://pm-guide.netguru.com/

MOOCs

1. https://www.edx.org/course/introduction-to-project-management?index=product&search_index=product&webview=false&campaign=Introduction+to+Project+Management&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fproject-management

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Scheme of Examination: (Theory courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO63C.1	2	3	3	3	2					2	3	2			2
CO63C.2	2	3	3	3	2					2	3	2			2
CO63C.3	2	3	3	3	2					2	3	2			2
CO63C.4	2	3	3	3	2					2	3	2			2
CO63C.5	2	3	3	3	2					2	3	2			2
Average	**2**	**3**	**3**	**3**	**2**					**2**	**3**	**2**			**2**

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

Course: RENEWABLE ENERGY TECHNOLOGY

Course Code	22MED63D	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	To introduce students to various energy sources, with a focus on solar radiation and its measurement, and to understand the energy scenario in India and globally.
CLO2	To provide students with an in-depth understanding of solar radiation geometry and its application in solar thermal and photovoltaic systems, focusing on practical aspects and system components.
CLO3	To introduce students to the principles and applications of wind and biomass energy, covering the characteristics, design, and challenges associated with these renewable energy sources
CLO4	To provide students with a comprehensive understanding of hydroelectric, tidal, and wave energy systems, including their mechanics, design, advantages, and limitations.
CLO5	To explore the principles and applications of ocean thermal energy conversion (OTEC) and geothermal energy.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Energy sources (including fossil fuels and nuclear energy), India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, Indian and global energy scenario. **Solar Radiation & Measurement:** Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Pyrometer, shading ring Pyrheliometer, sunshine recorder, schematic diagrams, and principle of working, actinometer and bolometer.	**08 Hours / L3**
Module 2 **Solar Radiation Geometry:** Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems. **Solar Thermal Systems:** Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower). **Solar Photovoltaic Systems:** Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction.	**08 Hours / L3**

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Module 3 **Wind Energy:** Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, design aspects, numerical examples. **Energy from Biomass:** Energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems associated with bio-gas production, application of biogas, application of biogas in engines, cogeneration plant, advantages & disadvantages.	**08 Hours / L3**
Module 4 **Hydroelectric plants:** Advantages & disadvantages of waterpower, Hydrographs and flow duration curves - numerical, Storage and pondage, General layout of hydel power plants-components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants. **Tidal Power:** Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations of tidal energy. **Energy from ocean waves:** Wave energy conversion, Wave energy technologies, advantages, and disadvantages.	**08 Hours / L3**
Module 5 **Ocean Thermal Energy Conversion**: Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC, case studies. **Geothermal energy:** Introduction, Principle of working, types of geothermal stations with schematic diagram Estimates of Geothermal Power, Nature of geothermal fields, Geothermal resources, Hydrothermal, Resources Geo pressured resources, Hot dry rock resources of petro-thermal systems, Magma Resources-Interconnection of geothermal fossil systems, Advantages, and disadvantages of geothermal energy over other energy forms, Geothermal stations in the world.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO63D.1	Evaluate the need for alternative energy sources and use advanced techniques for measuring and interpreting solar radiation data using specialized instruments.
CO63D.2	Analyze the geometric aspects of solar radiation and evaluate the design and functionality of various solar thermal and photovoltaic systems
CO63D.3	Evaluate the potential and challenges of wind energy and biomass energy by analyzing the design and characteristics of wind machines and biogas plants.
CO63D.4	Analyze the advantages and disadvantages of hydroelectric, tidal, and wave energy
CO63D.5	Analyze the principles and operational mechanisms of ocean thermal energy conversion and geothermal energy systems

Textbooks:

1. Solar Energy Principles, Thermal Collection &Storage, **S.P. Sukhatme**: Tata McGraw Hill Pub., New Delhi.
2. Non-Conventional Energy Sources, **G. D. Rai**, New Delhi.
3. Renewable Energy, power for a sustainable future, **Godfrey Boyle**,2004
4. The Generation of electricity by wind**, E. W. Golding.**
5. Non-Conventional Energy Resources by **B.H. Khan**, Tata McGraw Hill Pub.,2009

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Reference books:

1. Fundamentals of Renewable Energy Resources by **G.N.Tiwari**, M.K.Ghosal, Narosa Pub., 2007.
2. Non-Conventional Energy Resources by **B.H. Khan**, Tata McGraw Hill Pub., 2009.
3. Non-Conventional Energy Resources by **Shobh Nath Singh**, Pearson India., 2016
4. Environmental Justice in India: The National Green Tribunal, By **Gitanjali Nain Gill**, Routledge (2016).

E-Books / Web References

https://www.kobo.com/us/en/ebook/energy-the-environment-and-sustainability
https://www.taylorfrancis.com/books/mono/10.1201/b22169/energy-environment-Sustainabilityefstathios-michaelides

MOOCs

https://www.coursera.org/learn/exploring-renewable-energy
https://www.mooc-list.com/course/renewable-power-and-electricity-systems-coursera
https://www.edx.org/professional-certificate/usmx-environmental-management-for-sustainability

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO63D.1	**3**	2	2	**3**		1	1			1	2	1			1
CO63D.2	3	2	2	3		1	1			1	2	1			1
CO63D.3	3	2	2	3		1	1			1	2	1			1
CO63D.4	3	2	2	3		1	1			1	2	1			1
CO63D.5	3	2	2	3		1	1			1	2	1			1
Average	**3**	**2**	**2**	**3**		**1**	**1**			**1**	**2**	**1**			1

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

OPEN ELECTIVE COURSE

Course: Supply Chain Management and Introduction to SAP

Course Code	22MED64A	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management and Entrepreneurship

Course Objectives:

CLO1	Understand the stages, decision phases and process views in supply chain management
CLO2	Identify the major drivers of supply chain performance.
CLO3	Describe inventory management, transportation and the key factors considered in designing a distribution network.
CLO4	Develop a frame work for making network design decisions and coordination in supply chain.
CLO5	Discuss the importance of supply chain restructuring and the future of IT in supply chain management.

Content	No. of Hours/ RBT levels
Module 1 **Introduction: Supply Chain –** Fundamentals –Evolution Role in Economy – Importance Decision Phases –Supplier Manufacturer – Customer chain - Enablers/Drivers of Supply Chain Performance. Supply chain strategy Supply Chain Performance Measures. **Strategic Sourcing Outsourcing** – Make Vs buy Identifying core processes Market Vs Hierarchy Make Vs buy continuum – Sourcing strategy Supplier Selection and Contract Negotiation.	**8 Hours / L1, L2, L3**
Module 2 **Warehouse Management Stores management –** stores systems and procedures in-coming materials control stores accounting and stock verification Obsolete, surplus and scrap value analysis material handling transportation and traffic management operational efficiency productivity cost effectiveness performance measurement. **Supply Chain Network Distribution Network Design –** Role Factors Influencing Options, Value Addition – Distribution Strategies Models for Facility Location and Capacity allocation. Distribution Center Location Models.	**8 Hours / L1, L2, L3**
Module 3 **Supply Chain Network optimization models.** Impact of uncertainty on Network Design Network Design, decisions using Decision trees. Planning Demand, multiple item - multiple location inventory management. Pricing and Revenue Management.	**8 Hours / L1, L2, L3**

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Module 4 **Current Trends: Supply Chain Integration -** Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain Agile Supply Chain - Reverse Supply chain. Future of IT in supply chain - EBusiness in supply chain.	**8 Hours / L1, L2, L3**
Module 5 **Introduction to SAP:** SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code	**8 Hours / L1, L2, L3**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO64A.1	Understand the fundamentals and scope of Supply Chain management.
CO64A.2	Build and manage a competitive supply chain using strategies, models, techniques and information technology.
CO64A.3	Identify the role of network design and Plan the demand, inventory and supply and optimize supply chain network.
CO64A.4	Indentify the recent trends for effective supply chain management and the impact of IT in supply chain.
CO64A.5	Apply the SAP basics in industries for effective material, procurement and inventory management.

Textbooks:

1. **Sunil Chopra and Peter Meindl**, Supply Chain Management, 3rd Edition, Pearson Education 2007.
2. **Janat Shah**, Supply Chain Management, Text and Cases, Pearson Education 2009.

Reference books:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi.
2. Total Supply Chain Management by Ron Basu, J. Nevan Wright.
3. Supply Chain Management, Chopra, Pearson
4. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill.

E-Books / Web References

1. **https://onlinecourses.nptel.ac.in/noc21_mg45/preview**
2. **https://nptel.ac.in/courses/110106045**
3. **https://www.udemy.com/course/sapmmtraining/**
4. **https://www.udemy.com/course/saps4hanammsourcingandprocurement/**
5. **https://nptel.ac.in/courses/110105095.**

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NPTEL / MOOC

1. NPTEL Course: "Global Supply Chain Management" https://nptel.ac.in/courses/110108056
2. NPTEL Course: "Operations and Supply Chain Management " https://nptel.ac.in/courses/110106045
3. NPTEL Course: "Modelling and Analytics for Supply Chain Management'' https://nptel.ac.in/courses/110105141

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of three tests is taken. CIE is executed by way of one quiz / Alternate Assessment Tools (AATs), and average of three tests. One quiz is to be conducted and evaluated for 10 marks.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz 2/AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO64A.1	1								2	2	3	1			
CO64A.2	1								2	2	3	1			
CO64A.3	1								2	2	3	1			
CO64A.4	1								2	2	3	1			
CO64A.5	1								2	2	3	1			
Average	**1**								**2**	**2**	**3**	**1**			

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

OPEN ELECTIVE COURSE

Course: OPERATIONS RESEARCH

Course Code	22MED64B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Convert the real life situations to mathematical form and find optimal solutions.
CLO2	Draw the network showing the flow of activities and determine the completion of project.
CLO3	Predict the characteristics of queues like probability of waiting, waiting times, number of customers etc.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, **Linear programming Models**: Problem formulation and solution by graphical method. The simplex method using slack variables.	**08Hours / L1, L2, L3**
Module 2 **Transportation Problem:** Formulation of transportation problem, types, initial basic feasible solution using NWCR, LCEM VAM, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. **Assignment Problem:** Formulation, types, application to maximization cases and travelling salesman problem.	**08 Hours / L1, L2, L3**
Module 3 **PERT-CPM Techniques:** Introduction, network construction rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**08 Hours / L1, L2, L3**
Module 4 **Game Theory:** Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **Queuing Theory:** Introduction, Characteristics of Queueing systems, Representation of Queueing models by Kendal's Notation, Numericals on single channel queueing systems only.	**08 Hours / L1, L2, L3**

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Module 5	
Sequencing: Definitions and assumptions, Sequencing of 'n' jobs on 'm' (m=2, 3 and greater than 3) machines, Graphical method for sequencing of '2' jobs on 'm' machines.	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO64B.1	Formulate real-life problems using concepts Linear Programming and obtain the optimum solutions.
CO64B.2	Formulate real-life transportation and assignment problems to find the optimum solution.
CO64B.3	Construct the precedence diagram to find the duration of project.
CO64B.4	Formulate the competitive situations to find the winner of the game.
CO64B.5	Analyze the Queueing model for satisfaction of customer.
CO64B.6	Determine the sequence of jobs so as to minimize the total elapsed time for completion.

Textbooks:

1. **S D Sharma**, Operations Research, KNBN publishers
2. **Hamdy A.Taha**, Operations Research, PHI Private Limited, Seventh Edition, 2006

Reference books:

1. **A M Natarajan, P Balasubramani,** Operations Research, Pearson Education, 2005
2. **Hillier and Lieberman,** Introduction to Operations Research, McGraw Hill, 8th edition

E-Books / Web References

1. https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf
2. https://www.pdfdrive.com/introduction-to-operations-research-d14995994.html

MOOCs

3. https://nptel.ac.in/courses/110106062
4. https://nptel.ac.in/courses/111107128

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.
Some possible AATs:
Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO64B.1	2	2	1	1		1						1			2
CO64B.2	2	2	1	1		1						1			2
CO64B.3	2	2	1	1		1					2	1			2
CO64B.4	2	2	1	1		1					2	1			2
CO64B.5	2	2	1	1		1						1			2
CO64B.6	2	2	1	1		1						1			2
CO64B	2	2	1	1		1					2	1			2

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

OPEN ELECTIVE COURSE

Course: TOTAL QUALITY MANAGEMENT

Course Code	22MED64C	CIE Marks	50
Hours/Week (L: T: P)	3: 0: 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management & Entrepreneurship

Course Objectives: The students are taught to:

CLO1	Understand the various approaches to TQM and Quality management system.
CLO2	Explain The characteristics of quality leader and his role.
CLO3	Know the Develop feedback and suggestion systems for quality management.
CLO4	The knowledge in Tools and Techniques of quality management

Content	No. of Hours/ RBT levels
Module 1 **Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. **Quality Management Systems:** Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**08 Hours / L3**
Module 2 **Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.	**08 Hours / L3**
Module 3 **Customer Satisfaction and Customer Involvement:** Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. **Employee Involvement** – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**08 Hours / L3**
Module 4 **Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma. **Statistical Process Control:** Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	**08 Hours / L3**

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Module 5	
Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO64C.1	Evaluate various approaches to Total Quality Management (TQM) and analyze the standards and requirements of ISO 9000 and ISO 9001, including the benefits of implementing the ISO 9000 series.
CO64C.2	Assess the characteristics of quality leaders, effective individuals, and ethical considerations.
CO64C.3	Examine the importance of customer satisfaction and employee involvement through detailed case studies.
CO64C.4	Apply statistical tools for the continuous improvement of quality systems and evaluate their effectiveness in real-world scenarios.
CO64C.5	Implement tools and techniques for effective TQM and identify areas for quality improvement using Quality Function Deployment (QFD) and Failure Mode and Effects Analysis (FMEA).

Textbooks:

1. Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education. (First Indian Reprints 2004).
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002

Reference books:

1. M. Zairi, Total Quality Management for Engineers, Woodhead Publishing.
2. A New American TQM, four revolutions in management, ShojiShiba, Alan Graham, David Walden, Productivity press, Oregon.
3. 100 Methods for Total Quality Management: Gopal K. Kanji and Mike Asher, ISBN: 0803977476, Publisher: Sage Publications, Inc.; Edition – 1

E-Books / Web References

1. Gurus of TQM
   - https://www.focusstandards.org/quality-gurus-key-contributions
2. TQM Framework
   - https://www.emeraldinsight.com/doi/abs/10.1108/eb060192
3. Principles of TQM:
   - https://study.com/academy/lesson/five-principles-of-total-quality-managementtqm.html
4. Characteristics of quality leaders:
   - https://www.mechlectures.com/leadership-characteristics-quality-leaders/
   - https://www.briantracy.com/blog/leadership-success/the-sevenleadershipqualities-of-great-leaders-strategic-planning/
5. Customer Satisfaction and Customer Involvement
   - https://www.emeraldinsight.com/doi/abs/10.1108/17566691311316248
   - https://study.com/academy/lesson/consumer-involvement-in-the-decisionmakingprocess.html

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6. **Statistical Process Control**
    - http://asq.org/learn-about-quality/seven-basic-quality-tools/overview/overview.html
    - https://www.whatissixsigma.net/7-qc-tools/
7. **Design for Six Sigma**
    - https://quality-one.com/six-sigma/

MOOCs:

1. 1. NPTEL Course: "Total Quality Management" https://archive.nptel.ac.in/courses/110/104/110104080/
2. NPTEL Course: "Total Quality Management" https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg34/

Scheme of Examination:
Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**
The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO64C.1	**2**	1				1	1	1		1	3	2			2
CO64C.2	2	1				1	1	1		1	3	2			2
CO64C.3	2	1				1	1	1		1	3	2			2
CO64C.4	2	1				1	1	1		1	3	2			2
CO64C.5	2	1				1	1	1		1	3	2			2
Average	**2**	**1**				**1**	**1**	**1**		**1**	**3**	**2**			2

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

OPEN ELECTIVE COURSE

Course: MODERN MOBILITY

Course Code	22MED64D	CIE Marks	50
Hours/Week (L: T: P)	3: 0: 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Objectives:

CLO1	To understand the different chassis design & main components of automobile
CLO2	To understand the working of transmission and control system employed in automobiles
CLO3	To understand the automotive pollution and alternative automotive technologies under trail
CLO4	To understand the upcoming electric vehicle technology

Content	No. of Hours/ RBT levels
Module 1 **Mobility Systems:** History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Modern Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System.	**08 Hours / L3**
Module 2 **Power Transmission:** Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)& IMT, Working of Differential. Types Of Tyres Radial & Conventional, Tubeless Tyres, Tubed Tyres Puncture patching	**08 Hours / L3**
Module 3 **Direction Control & Braking:** Steering system mechanisms & Linkages, Steering gear boxes Rack & pinion, worm & wheel construction & working, power Steering construction & working, steering geometry, Wheel balancing Braking System Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS Suspension – layout & working of Hydraulic& Air suspension, independent suspension	**08 Hours / L3**
Module 4 **Exhaust Emission & Alternate Sources** Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuel types, extraction& availability, BIOFUELS – Production and impact. Ethanol engines, CNG vehicles operation, advantages 56 & disadvantages, overview of Hydrogen fuel cell	**08 Hours / L3**

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vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles overview, layout, transmission & control system, solar powered vehicles wind-powered vehicles, supercapacitors, supply rails	
Module 5 **Electrical Vehicles:** Electric vehicles principle and components layout of two & 4wheeler, Motors used in Electric vehicles –types overview of construction and working, power transmission & control system in Electric vehicles. Batteries – construction & working principle of Lead acid, nickel-based, sodium-based, Lithium & Metal Air batteries. Battery charging types and requirements.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO64D.1	Understand the working of different systems employed in automobile
CO64D.2	Analyse the limitation of present-day automobiles
CO64D.3	Evaluate the energy sources suitability
CO64D.4	Apply the knowledge for selection of automobiles based on their suitability

Textbooks:

1. Electric Vehicle Technology Explained James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK
2. Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011.
3. Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.
4. Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007.

Reference books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, YiminGao, CRC Press, Taylor & Francis Group
2. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
3. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
4. Automobile Engineering, R. B. Gupta, SatyaPrakashan,(4th Edition)

E-Books / Web References

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://onlinecourses.nptel.ac.in/noc20_de06/preview
3. https://www.digimat.in/nptel/courses/video/107106088/L01.html
4. https://nptel.ac.in/courses/107106088
5. https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J

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Scheme of Examination: (Theory courses)
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,
CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO64D.1	3	2	1							1		1			3
CO64D.2	3	2	1							1		1			3
CO64D.3	3	2	1							1		1			3
CO64D.4	3	2	1							1		1			3
Average	3	2	1							1		1			3

Low - 1: Medium - 2: High - 3

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Course: Major Project Phase - I

Course Code	22MEDP65	CIE Marks	100
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	-
No. of Credits	02	Examination Hours	03

CIE for Project Phase - II:

1. **Single discipline:** The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates using Rubrics.

2. **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes.

SEE for Project Phase - II:

1. **Single discipline:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
2. **Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-II	**50**	50
	Review-III	**50**	
SEE		**50**	50
Grand Total			**100**

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SEMESTER – VI

Course: ANALYSIS LABORATORY

Subject Code	**22MEDL66**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 2**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to,

CLO1	Get acquainted to modeling and analysis in ANSYS APDL interface.
CLO2	Understand the concepts of different kinds of loading and boundary conditions and analyze the results with respect to field variables.

Sl. No.	**Experiments**	**No. of Hours/ RBT levels**
	Part- A-One dimensional Analysis	
1	**Analyses of Bars** - Bars of constant cross section area, tapered cross section area and stepped bar with different materials.	**10 Hours / L3**
2	**Analyses of trusses -** (Minimum 3 exercises of different areas of cross sections of links, different supports such as fixed support, rolling support)	
3	**Analyses of Beams** - Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. (Minimum 6 exercises)	
4	**Dynamic Analyses of beams.**	
	Part – B -Two-dimensional Analysis	
1	Plane stress problems, Plane strain problems	**10 Hours / L3**
2	Axisymmetric problems	
3	Heat Transfer Analyses	
	Part – C- Three dimensional Analyses (Demonstration only)	
1	**Can be Demo experiments for CIE** Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver	**08 Hours / L3**
2	**Can be Demo experiments for CIE** Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.	
3	**Can be Demo experiments for CIE** Demonstrate at least two different type of example to model and analyze bars or plates made from composite material	

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Course Outcomes: Upon successful completion of this course, student will be able to

CO66.1	Create geometric model of the structure, apply the boundary conditions and loads.
CO66.2	Perform stress, dynamic and thermal analysis.
CO66.3	View the required results (displacements, deformations, stresses temperatures etc.)
CO66.4	Validate the obtained results.

Textbooks:

1. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.
2. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001

Reference books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.
2. Bathe K. J. Finite Elements Procedures, PHI. 2.
3. Cook R. D., et al. "Concept sand Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

Scheme of Examination:

Semester End Examination (SEE):

One question from part A	**40 Marks**
One question from part B	**40 Marks**
Viva Voce	**20 Marks**

Note: SEE will be conducted for 100 Marks and reduced to 50

Continuous Internal Evaluation (CIE):

Weekly performance - Lab participation + Report	**30 Marks**
One Internal Assessment at the end of semester	**20 Marks**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO66.1	3	3	-	-	3	2						3	2		
CO66.2	3	3	3	3	3							3	2		
CO66.3	3	3	3	3	3							3	2		
CO66.4	3	3	3	3	3					3		3	2		
Average	3	3	3	2	3	2				3		3	2		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

ABILITY ENHANCEMENT COURSE - III

BASICS of MATLAB

Course Code	**22MED67A**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0 : 0 : 2**	**SEE Marks**	**50**
No. of Credits	**2**	**Examination Hours**	**03**

Prerequisites:

Course Objectives:

CLO1	To know about fundamentals of MATLAB tool.
CLO2	To know about fundamentals of MATLAB tool.
CLO3	To understand the concept and importance of Fourier transforms.
CLO 4	To gain knowledge about MATLAB Simulink & solve engineering problems.

List of Experiments
Experiment 1 Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
Experiment 2 Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.
Experiment 3 Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.
Experiment 4 MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems.
Experiment 5 Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using GaussSiedal and NewtonRaphson method.
Experiment 6 MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO67A.1	Implement loops, branching, control instruction and functions in MATLAB programming environment.
CO67A.2	Programming for curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve engineering problems.
CO67A.3	Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
CO67A.4	Simulate MATLAB Simulink examples.

Textbooks:

1. Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", OXFORD Higher Education.
2. Dr. Shailendra Jain, "Modelling & Simulation using MATLAB – Simulink", Wiley – India.

Reference books:

1. Won Y.Tang, Wemun Cao, Tae Sang Ching and John Morris, "Applied Numerical Methods Using MATLAB", A John Wiley & Sons.
2. Steven T. Karris, "Introduction to Simulink with Engineering Applications", Orchard Publications.

E-Books / Web References

1. **https://onlinecourses.nptel.ac.in/noc20_ge05/preview**

Scheme of Examination: (Theory courses)
Assessment Details (both CIE and SEE): The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for theSEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE(Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Semester End Examination (SEE): SEE marks for the practical course are 50 Marks.
SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
All laboratory experiments are to be included for practical examination.
(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners.
Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
Evaluation of test writeup/conduction procedure and result/viva will be conducted jointly by examiners.
General rubrics suggested for SEE are mentioned here, writeup 20%, Conduction procedure and result in 60%, Vivavoce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks
and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be

decided by the examiners) Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

Continuous Internal Evaluation (CIE): CIE marks for the practical course are 50 Marks.
The splitup of CIE marks for record/ journal and test are in the ratio 60:40.
Each experiment is to be evaluated for conduction with an observation sheet and record writeup.
Rubrics for the evaluation of the journal/writeup for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.Record should contain all the specified experiments in the syllabus and each experiment writeupwill be evaluated for 10 marks.Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).Weightage to be given for neatness and submission of record/writeupon time.Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.In a test, test writeup,conduction of experiment, acceptable result, and procedural knowledge willcarry a weightage of 60% and the rest 40% for viva voce.

The suitable rubrics can be designed to evaluate each student's performance and learning ability.
The marks scored shall be scaled down to 20 marks (40% of the maximum marks).
The Sum of scaleddown marks scored in the report writeup/ journal and marks of a test is the total CIE marks scored by the student.

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO67A.1	3	1													
CO67A.2	3	1	1				1								
CO67A.3	3	1										1			
CO67A.4	3	1								1					
Average	**3**	**1**	**1**		**1**		**1**			**1**		**1**			

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

ABILITY ENHANCEMENT COURSE - III

Fundamental of Virtual Reality ARP Development

Course Code	22MED67B	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Objectives: The students will be taught:

CO1	Describe how VR systems work and list the applications of VR.
CO2	Understand the design and implementation of the hardware that enables VR systems to be built.
CO3	Understand the system of human vision and its implication on perception and rendering.
CO4	Explain the concepts of motion and tracking in VR systems.
CO5	Describe the importance of interaction and audio in VR systems.

Content
Module 1
Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World Input & output Visual,Aural & Haptic Displays, Applications of Virtual Reality.
Module 2
Representing the Virtual World: Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR
Module 3
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.
Module 4
Visual Perception & Rendering: Visual Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.
Module 5
Motion & Tracking: Motion in Real and Virtual Worlds Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies.

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO67B.1	Describe how VR systems work and list the applications of VR.
CO67B.2	Understand the design and implementation of the hardware that enables VR systems to be built.
CO67B.3	Understand the system of human vision and its implication on perception and rendering.
CO67B.4	Explain the concepts of motion and tracking in VR systems
CO67B.5	Describe the importance of interaction and audio in VR systems.

Text Books:

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India,2003.

WEB/ONLINE REFERENCES

http://lavalle.pl/vr/book.html
https://nptel.ac.in/courses/106/106/106106138/
https://www.coursera.org/learn/introductionvirtualreality.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Course Seminars

Assessment Details (both CIE and SEE):

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE):

The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and any two Assessment methods for 25 marks.

The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered. Any two assessment methods mentioned in the 22OB4.2 if an assignment is project based

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Then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
For the course, CIE marks will be based on a scaled down sum of two tests and other methods of assessment for a total of 50 marks.
Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.
OR
MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then
1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub questions (with maximum sub questions of 02, with marks distributions (5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO67B.1	3	2	2										2		
CO67B.2	3	2	2										2		
CO67B.3	3	2	2										2		
CO67B.4	3	2	2										2		
CO67B.5	3	2	2						1	1		2	2		
Average	**3**	**2**	**2**						**1**	**1**		**2**	**2**		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

ABILITY ENHANCEMENT COURSE - III

INTRODUCTION AUGMENTED REALITY

Course Code	22MED67C	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Objectives: To enable students to apply the knowledge of materials and alloys by making them learn the:

CLO1	Describe how AR systems work and list the applications of AR.
CLO2	Understand and analyse the hardware requirement of AR.
CLO3	Use computer vision concepts for AR and describe AR techniques
CLO4	Analyse and understand the working of various state of the art AR devices
CLO5	Acquire knowledge of mixed reality

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Augmented Reality (A.R):** Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other TechnologiesMedia,Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality **Augmented Reality Concepts:** Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.	**08 Hours / L1, L2, L3**
Module 2 **Augmented Reality Hardware:** Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. **Processors** – Role of Processors, Processor System Architecture, Processor Specifications. **Tracking & Sensors** Tracking,Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.	**08 Hours / L1, L2, L3**
Module 2 **Computer Vision for Augmented Reality & A.R. Software**: Computer Vision for Augmented Reality Marker Tracking, Multiple Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking. **Augmented Reality Software** Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.	**08 Hours / L1, L2, L3**

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Module 4 **AR Technique sMarker based & Marker less tracking**: Markerbased approach Introduction to markerbased tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication **Marker types** Template markers, 2D barcode markers, imperceptible markers. Markerless approach Localization based augmentation, real world examples Tracking methodsVisual tracking, feature based tracking, hybrid tracking, and initialization and recovery.	**08 Hours / L1, L2, L3**
Module 5 **AR Devices & Components: AR Components** – Scene Generator, Tracking system, monitoring system, display, Game scene **AR Devices** – Optical See through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see through systems	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO67C.1	Describe how AR systems work and list the applications of AR.
CO67C.2	Describe how AR systems work and list the applications of AR.
CO67C.3	Apply computer vision concepts for AR and describe AR techniques
CO67C.4	Analyse and understand the working of various state of the art AR devices
CO67C.5	Explain the knowledge acquired on mixed reality

Textbooks:

1. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India;

Reference books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, 2. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
2. Sanni SiltanenTheory and applications of markerbased augmented reality

E-Books / Web References

- https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
- https://docs.microsoft.com/enus/
- windows/mixedreality/
- https://docs.microsoft.com/enus/
- archive/msdnmagazine/2016/november/hololensintroductiontotheholoLens

MOOCs

- https://www.coursera.org/learn/ar

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course seminar
- Term project

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Assessment Details (both CIE and SEE)

- The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.
- **Continuous Internal Evaluation:**

  The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered Any two assessment methods mentioned in the 22OB , if an assignment is project based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
  For the course, CIE marks will be based on a scaled down sum of two tests and other methods of assessment for a total of 50 marks.
  Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

  Semester End Examinations (SEE)
  SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO67C.1	3	1	1			1	1					1	1		
CO67C.2	3	1	1			1	1					1	1		
CO67C.3	3	1	1			1	1					1	1		
CO67C.4	3	1	1			1	1					1	1		
CO67C.5	3	1	1			1	1					1	1		
Average	3	**1**	**2**			**1**	**1**					**1**	1		

Low - 1: Medium - 2: High - 3

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SEMESTER – VI

ABILITY ENHANCEMENT COURSE- III

Simulation and Analysis using Ansys workbench

Course Code	22MED67D	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Objectives: To enable students to apply the knowledge of materials and alloys by making them learn the:

CLO1	General understanding of the user interface, as related to geometry import, meshing, application of loads and supports, and postprocessing.
CLO2	Procedure for performing FEA simulations, including linear static, modal, and harmonic structural analyses and nonlinear steady state thermal analyses.
CLO3	Utilizing parameters for 'what-if' scenarios
CLO4	To launch the individual software components and used to transfer data between them
CLO5	To see at a glance how a model has been built, and determine which files were used for a particular simulation (pairing geometry files to solver runs)
CLO6	To perform parametric analyses (without the user needing to manually launch each application in turn) and makes it easy to simulate Multiphysics scenarios like fluid structure interaction

Sl.NO	Experiments
1	Bars of constant cross section area, tapered cross section area and stepped bar.
2	Trusses
3	Beams and (Simply supported, cantilever, beams with UDL, and beams with varying load etc.)
4	Frames
5	Stress analysis of a rectangular plate with a circular hole, axisymmetric problems
6	Thermal Analysis 2D problem with conduction and convection boundary conditions
7	Fluid flow Analysis Potential distribution in the 2 D bodies
8	Magnetostatic: – Perform various magnetic field analyses
	Demonstration Experiments (For CIE)
9	Electrical: – Simulate electrical devices such as motors, solenoids,
10	Fixed fixed beam for natural frequency determination
11	Bar subjected to forcing function
12	Fixed fixed beam subjected to forcing function

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO67D.1	Covers fundamentals and practical knowledge of finite element modelling and simulation
CO67D.2	Uses ANSYS Workbench as the FEA environment Describes simulation case studies demonstrated in a step by step fashion Includes a web based geometry input CAD files for ANSYS Workbench examples Covers the analyses of trusses, beams, frames, plane stress and plane strain problems, plates and shells, three dimensional design components, and assembly structures.
CO67D.3	APPLY basics of Theory of Elasticity to continuum problems
CO67D.4	FORMULATE finite elements like bar, truss and beam elements for linear static structural analysis. FORMULATE 2D and axisymmetric finite elements
CO67D.5	Develop finite element equations for 1D heat transfer elements and solve numerical
CO67D.6	Apply finite element simulation tool to solve practical problems (Lab and Self study).

Suggested Learning Resources:

1. www.ansys.com

2.www.mece.ualberta.ca/tutorials/ansys

3. http://mae.uta.edu/~lawrence/

4. http://expertfea.com/tutorials.html

Assessment Details (both CIE and SEE)

- The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

- **Continuous Internal Evaluation:**
  The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 25 marks. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered Any two assessment methods mentioned in the 22OB , if an assignment is project based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
  For the course, CIE marks will be based on a scaled down sum of two tests and other methods of assessment for a total of 50 marks.
  Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

  Semester End Examinations (SEE)
  SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

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CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO67D.1	3	1	1			1	1		1	1		1	1		
CO67D.2	3	1	1			1	1		1	1		1	1		
CO67D.3	3	1	1			1	1		1	1		1	1		
CO67D.4	3	1	1			1	1		1	1		1	1		
CO67D.5	3	1	1			1	1		1	1		1	1		
CO67D.6	3	1	1			1	1		1	1		1	1		
Average	3	**1**	**2**			**1**	**1**		**1**	**1**		**1**	1		

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: Indian Knowledge System

Course Code	22IKSK69	CIE Marks	50
Hours/Week (L: T: P)	1:0:0	SEE Marks	50
No. of Credits	0	Examination Hours	01

Course Objectives:

CLO1	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system
CLO2	To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life.

Content
Module 1 (05 hours)
Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.
Module 2 (05 hours)
Traditional Knowledge in Humanities and Sciences: Lingistics, Number and measurements-Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology
Module 3 (05 hours)
Traditional Knowledge in Professional domain: Town planning and architecture Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.

Reference Books:

1. Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93- 91818-21-0
2. Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230,
3. Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO 1	Provide an overview of the concept of the Indian Knowledge System and its importance.
CO 2	Appreciate the need and importance of protecting traditional knowledge.
CO 3	Recognize the relevance of Traditional knowledge in different domains.
CO 4	Establish the significance of Indian Knowledge systems in the contemporary world

Scheme of Examination:

Semester End Examination (SEE):
SEE paper shall be set for 50 questions, each of the 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.
Continuous Internal Evaluation (CIE):

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Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.
Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO	**PO6**
CO 1	3
CO 2	3
CO 3	3
CO 4	3
Average	3

Low-1: Medium-2: High-3

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SEMESTER – VI

Course: UNIVERSAL HUMAN VALUES

Course Code	22UHV69	CIE Marks	50
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	50
No. of Credits	0	Examination Hours	01

Course Objectives:

CLO1	To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
CLO2	To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
CLO3	To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
CLO4	To provide a much-needed orientation input in value education to the young enquiring minds.

Content
Module 1 (03 hours)
Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations
Module 2 (03 hours)
Harmony in the Human Being : Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health
Module 3 (03 hours)
Harmony in the Family and Society : Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order
Module 4 (03 hours)
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence
Module 5 (03 hours)
Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

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Reference Books:

1. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034-47-1
2. The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

COURSE OUTCOMES: Upon completion of this course, the student would:

CO 1	Become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
CO 2	Have better critical ability
CO 3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO 4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

Scheme of Examination:

Semester End Examination (SEE):
SEE paper shall be set for 50 questions, each of the 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by quizzes / Alternate Assessment Tools (AATs), and three tests. Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

Component		Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignments	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO	**PO6**
CO 1	3
CO 2	3
CO 3	3
CO 4	3
Average	3

Low-1: Medium-2: High-3

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VII - VIII SEMESTER
SCHEME AND SYLLABUS
Department of
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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

Scheme A- VII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD)and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lect	Tutorial	Practical/ Drawi	Self - Study	Duration in hour	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED71	Industrial Robotics	TD: ME, PSB:ME	3	0	0		03	50	50	100	3
2	PCC	22MED72	Operations Research	TD: ME, PSB:ME	3	0	0		03	50	50	100	3
3	PCC	22MED73	Control Engineering	TD: ME, PSB:ME	3	2	0		03	50	50	100	4
4	PEC	22MED74x	**Professional Elective-III**	TD: ME PSB:ME	3	0	0		03	50	50	100	3
5	OEC	22MED75x	**Open Elective- II**	TD: ME PSB:ME	3	0	0		01	50	50	100	3
6	PROJ	22MEDP76	**Major Project Phase-II**		0	0	12		03	100	100	200	6
7	PCCL	22MEDL77	Design Laboratory	TD: MEPSB:ME	0	0	2		03	50	50	100	1
8	PCCL	22MEDL78	Energy Engineering Laboratory	TD: ME PSB:ME	0	0	2		03	50	50	100	1
									Total	**450**	**450**	**900**	**24**

Professional Elective - III

22MED74A	Design for Manufacturing and Assembly	22MED74C	Total Quality Management
22MED74B	Thermal Management of Electronic Equipment	22MED74D	Automotive Engineering & Hybrid Vehicle Technology

Open Elective - II

22MED75A	Additive Manufacturing	22MED75C	Renewable Energy Power plants
22MED75B	Project and Operations Management	MED23705D	Strategies for Sustainable Design

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI Semester

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semester.

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK (21MEP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve ingroup discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the Department concerned and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

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(Effective from the academic year 2023-24)

Scheme A- VIIISEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	22MED81x	Professional Elective - IV (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	OEC	22MED82x	Open Elective - III (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
3	INT	22MEDI83	Internship (Industry/Research) (14 - 20 weeks)	TD: ME	0	0	12		03	100	100	200	10
									Total	**200**	**200**	**400**	**16**

Professional Elective - IV (Online courses)

22MED81A	Quality Design & Control (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_mg24/preview	22MED81C	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc22_me60/preview
22MED81B	Product Design and Manufacturing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_me66/preview	22MED81D	Computer Integrated Manufacturing (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc22_me10/preview

Open Elective - III (Online Courses)

22MED82A	Fundamentals of automotive systems (Available in NPTEL) https://archive.nptel.ac.in/courses/107/106/107106088/	22MED82C	Strategies for Sustainable Design (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc21_de07/preview
22MED82B	Industrial Safety Engineering (Available in NPTEL) https://onlinecourses.nptel.ac.in/noc20_mg43/preview	22MED82D	Business Planning & Project Management (Available in NPTEL) https://onlinecourses.swayam2.ac.in/cec21_ge06/preview

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L: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship

Note: VII and VIII semesters of IV years of the program

Swapping Facility

- Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ industry internships/Rural Internship** after the VI semester**.**
- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.

Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, centre of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.

The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship.

The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. **University shall not bear any cost involved in carrying out the internship by students.** However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the VTU web portal.

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(Effective from the academic year 2023-24)

Scheme B-VI SEMESTER for the candidates who seek a two-semester internship with project work /Start-up

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED61	Finite Element Methods	TD: ME PSB:ME	3	0	2		03	50	50	100	3
2	IPCC	22MED62	Heat Transfer	TD: ME PSB:ME	3	0	2		03	50	50	100	4
3	PEC	22MED63X	Professional Elective - II	TD: ME PSB: ME	4	0	0		03	50	50	100	3
4	OEC	22MED64X	Open Elective - 1	TD: ME PSB: ME	3	0	0		03	50	50	100	3
5	PCCL	22MEDL66	Analysis Laboratory	TD: ME PSB: ME	3	0	0		01	50	50	100	1
6	AEC	22MED67X	Ability Enhancement Course/Skill Development Course III	TD: ME PSB:ME	If the course is offered as a Theory: 2	0	0		03	50	50	100	2
					If course is offered as a practical: 1	0	2						
7	MC	NSK2268	National Service Scheme (NSS)	NSS coordinator	0	0	2		03	100	-	100	0
		PEK2268	Physical Education (PE) (Sports and Athletics)	Physical Education Director					03				
		YOK2268	Yoga	Yoga Teacher					01				
8	IKS	IKSK2269	Indian Knowledge System	Any Department	0	0	12		03	100	0	100	0
									Total	**500**	**300**	**800**	**16**

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Scheme B: VII and VIII semesters for the candidates who seek an internship with project work

Sl. No	Course and Course Code		Course Title	Teaching Department (TD)and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration inhours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MED71	Industrial Robotics To be completed in 5th/6th semester	TD: ME PSB:ME	3	0	2		03	50	50	100	3
2	PCC	22MED72	Hydraulics and Pneumatics To be completed in 5th /6th semester	TD: ME PSB:ME	3	0	2		03	50	50	100	3
3	PCC	22MED73	Control Engineering To be completed in the 6th semester	TD: ME PSB: ME	4	0	0		03	50	50	100	3
4	PEC	22MED74x	Professional Elective Course (MOOC Courses)	TD: ME PSB: ME	3	0	0		03	50	50	100	3
5	OEC	22MED75x	Open Elective Courses (MOOC courses)	TD: ME PSB: ME	3	0	0		01	50	50	100	3
6	PCCL	22MED77	Design Laboratory To be completed in 5th /6th semester	TD: ME PSB:ME	0	0	2		03	50	50	100	1
7	PCCL	22MED78	Energy Engineering Laboratory To be completed in 5th /6th semester	TD: ME PSB:ME	0	0	2		03	50	50	100	1
1	PEC	22MED81x	Professional Elective -IV (Online Courses)	TD: ME PSB:ME	3	0	0		03	50	50	100	3
2	OEC	22MED82x	Open Elective - III (Online Courses)	TD: ME PSB:ME	3	0	0		01	50	50	100	3
3	PROJ	22MED83	Project – Outcome of Training	TD: ME PSB:ME	0	0	12		03	100	100	200	9
4	INT	22MED84	Internship (Industry/Research) (02 semesters)	TD: ME	0	0	12		03	100	100	200	10
									Total	**650**	**650**	**1300**	**42**

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VII SEMESTER

SYLLABUS

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SEMESTER – VII

Course: Industrial Robotics

Course Code	22MED71	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Understand the fundamental concepts and technical specifications of industrial robotics, including robot anatomy, configurations, and control systems.
CLO2	Understand and apply the principles of 2D transformations including matrix representation.
CLO3	Understand the different types of sensors used in robotics applications.
CLO4	Understand key concepts and techniques in robot programming, including different programming levels .
CLO5	Understand the material handling systems and its principles and the material transport systems.

Content	No. of Hours/ RBT levels
Module 1 **Industrial Robotics:** Definition of Robotics, robot anatomy, joints and end effectors, Robotic configuration, Work volume, Robot motions, Robot drive system, Precision of movement: Spatial resolution, Accuracy and Repeatability. Degrees of freedom, Asimov's laws of robotics, Robot specifications.	**8 Hours / L1,L2, L3**
Module 2 **Basic control systems and components:** Basic control systems concepts and models, Controllers, control system analysis, **Transformations:** 2D transformations, translation, rotation (Rotation about x, y, z axis) and scaling. Introduction to Direct and inverse kinematics. (only definition)	**8 Hours / L1,L2, L3**
Module 3 **Robot End Effector:** Types of End effectors, Mechanical Grippers, Other types of Grippers, Tools and End effector, The Robot/End effector interface Consideration in Gripper selecting and Design. **Sensors in Robotics:** Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics**.**	**8 Hours / L1,L2, L3**
Module 4 **Robot Programming:** Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods	**8 Hours / L1,L2, L3**
Module 5 **Material handling and Identification Technologies:** Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.	**8 Hours / L1,L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO71.1	Apply the principles of robot anatomy, configurations to optimize the precision and efficiency of robotic movements in industrial applications
CO71.2	Analyze 2D transformations to effectively control robotic movements.
CO71.3	Describe the End effectors and sensors used in robot applications.
CO71.4	Develop robot programs, addressing issues related to robot programming languages, offline programming systems, and automating subtasks, while implementing simple programs for practical robot applications.
CO71.5	Describe the design considerations for material handling systems and transport systems.

Textbooks:

1. Computer Integrated Manufacturing - Mikell P. Groover, Pearson, 3rd edition, 2009.
2. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2 nd Edition, Tata McGraw Hill, 2012.
3. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2 nd Edition, PHI, 2011

Reference books:

1. Robotics for Engineers - Yoram Koren, McGraw Hill International, 1st edition, 1985.
2. Industrial Robotics - Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
3. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.
4. Computer Based Industrial Control - Krishna Kant, EEE-PHI, 2nd edition, 2010.
5. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.

E-Books / Web References

1. Fundamentals of Robot Technology: An Introduction to Industrial Robots, Tele operators and Robot Vehicles: https://www.pdfdrive.com/fundamentals-of-robot-technology-an introduction-to-industrial-robots-teleoperators-and-robot-vehicles-d1.
2. Robot Operating System for Absolute Beginners: Robotics Programming Made Easy: https://www.pdfdrive.com/robot-operating-system-for-absolute-beginners-roboticsprogramming-made-easy-e176394485.html.
3. Introduction to Robotics:
   http://www.mech.sharif.ir/c/document_library/get_file?uuid=5a4bb247-1430-4e46-942cd692dead831f&groupId=14040
   https://www.researchgate.net/publication/273697873_Introduction_to_Robotics

MOOCs

1. NPTEL Course: "ROBOTICS" : https://nptel.ac.in/courses/112105249
2. NPTEL Course "Introduction to Robotics": https://onlinecourses.nptel.ac.in/noc20_de11/preview

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO71.1	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-
CO71.2	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-
CO71.3	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-
CO71.4	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-
CO71.5	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-
Average	3	2	2	-	-	1	-	-	-	-	-	2	2	-	-

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: OPERATIONS RESEARCH

Course Code	22MED72	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Convert the real life situations to mathematical form and find optimal solutions.
CLO2	Draw the network showing the flow of activities and determine the completion of project.
CLO3	Predict the characteristics of queues like probability of waiting, waiting times, number of customers etc.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, **Linear programming Models**: Problem formulation and solution by graphical method. The simplex method using slack variables.	**08Hours / L1, L2, L3**
Module 2 **Transportation Problem:** Formulation of transportation problem, types, initial basic feasible solution using NWCR, LCEM VAM, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. **Assignment Problem:** Formulation, types, application to maximization cases and travelling salesman problem.	**08 Hours / L1, L2, L3**
Module 3 **PERT-CPM Techniques:** Introduction, network construction rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**08 Hours / L1, L2, L3**
Module 4 **Game Theory:** Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **Queuing Theory:** Introduction, Characteristics of Queueing systems, Representation of Queueing models by Kendal's Notation, Numericals on single channel queueing systems only.	**08 Hours / L1, L2, L3**
Module 5 **Sequencing:** Definitions and assumptions, Sequencing of 'n' jobs on 'm' (m=2, 3 and greater than 3) machines, Graphical method for sequencing of '2' jobs on 'm' machines.	**08 Hours / L1, L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO72.1	Formulate real-life problems using concepts Linear Programming and obtain the optimum solutions.
CO72.2	Formulate real-life transportation and assignment problems to find the optimum solution.
CO72.3	Construct the precedence diagram to find the duration of project.
CO72.4	Formulate the competitive situations to find the winner of the game.
CO72.5	Analyze the Queueing model for satisfaction of customer.
CO72.6	Determine the sequence of jobs so as to minimize the total elapsed time for completion.

Textbooks:

1. **S D Sharma**, Operations Research, KNBN publishers
2. **Hamdy A.Taha**, Operations Research, PHI Private Limited, Seventh Edition, 2006

Reference books:

1. **A M Natarajan, P Balasubramani,** Operations Research, Pearson Education, 2005
2. **Hillier and Lieberman,** Introduction to Operations Research, McGraw Hill, 8th edition

E-Books / Web References

1. https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf
2. https://www.pdfdrive.com/introduction-to-operations-research-d14995994.html

MOOCs

3. https://nptel.ac.in/courses/110106062
4. https://nptel.ac.in/courses/111107128

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

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CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO72.1	2	2	1	1		1						1			2
CO72.2	2	2	1	1		1						1			2
CO72.3	2	2	1	1		1					2	1			2
CO72.4	2	2	1	1		1					2	1			2
CO72.5	2	2	1	1		1						1			2
CO72.6	2	2	1	1		1						1			2
CO72	2	2	1	1		1					2	1			2

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: CONTROL ENGINEERING

Course Code	22MED73	CIE Marks	50
Hours/Week (L: T: P)	3: 2 : 0	SEE Marks	50
No. of Credits	4	Examination Hours	03

Prerequisites: Basic Mathematics

Course Objectives: The students will be taught to:

CLO1	Appreciate the importance of control systems in mechanical engineering.
CLO2	Represent the vibration system as electrical systems.
CLO3	Draw the Root locus, Bode, Polar and Nyquist plot for the given transfer system for further analyses.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system. **Mathematical Models:** Models of vibration systems, Transfer function, Numerical on F-I and F-V analogy of vibration systems.	**10 Hours / L1, L2, L3**
Module 2 **Block Diagrams Algebra:** block representation of system elements, reduction of block diagrams, Transfer function of SFG using Mason's formula. **Transient and Steady State Response Analysis:** Different types of inputs, Response of first order and second order to step, ramp and impulse inputs (no derivation), time response specifications and concepts of time constant, numerical problems.	**10 Hours / L1, L2, L3**
Module 3 **Root Locus Plots:** Definition, general rules for constructing root loci, Numerical on plotting the root locus for given transfer function.	**10 Hours / L1, L2, L3**
Module 4 **Frequency Response Analysis:** Relationship between time and frequency response, Bode attenuation plot, Phase and gain margins. **Polar and Nyquist plot:** Simple numerical Phase and gain margins**.**	**10 Hours / L1, L2, L3**
Module 5 **Controllers and System Compensation**: Different types of controllers (P, I, D, PI, PD and PID)**,** Series and feedback compensation.	**10 Hours / L1, L2, L3**

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State Variable Characteristics of Linear Systems : Introduction to state concepts, state equation of linear system. Matrix representation of state equations, controllability and observability, Kalman and Gilbert's test for controllability and observability.	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO73.1	Explain different types of control systems and convert the vibrational systems to electrical systems.
CO73.2	Derive the transfer function for the control systems using Block diagram reduction techniques and signal flow graphs.
CO73.3	Deduce the time domain response analysis of 1st and 2nd order control systems.
CO73.4	Construct the root locus, Bode, Polar and Nyquist plot for the given transfer function.
CO73.5	Explain the different types of controllers and system compensation.
CO73.6	Determine the observability and controllability of a system

Textbooks:

1. **Farid G., Kuo B. C**, Automatic Control Systems, McGraw Hill Education, 10th Edition,2018
2. **K. Ogata**, Modern control Engineering, Pearson, 5th Edition, 2010

Reference books:

1. **I J Nagrath, M Gopal,** Control Systems Engineering, New Age International (P) Ltd, 2018.
2. **M.Gopal**, Control systems Principles and Design, 3rd Edition, TMH, 2000.

E-Books / Web References

1. https://www.pdfdrive.com/electrical-and-electronics-engineering-u-bakshi-v-bakshi-d188397301.html
2. https://www.pdfdrive.com/electrical-and-electronics-engineering-u-bakshi-v-bakshi-d188397301.html

MOOCs

3. https://nptel.ac.in/courses/108106098
4. https://onlinecourses.nptel.ac.in/noc20_ee90/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of three tests and a quiz / Alternate Assessment Tools (AATs) for 10 marks.

Some possible AATs:

Assignments/ group activity / any other.

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Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO73.1	2	2	2	2		1	1					1	2		
CO73.2	2	2	2	2		1	1					1	2		
CO73.3	2	2	2	2		1	1					1	2		
CO73.4	2	2	2	2		1	1					1	2		
CO73.5	2	2	2	2		1	1					1	2		
CO73.6	2	2	2	2		1	1					1	2		
CO73	2	2	2	2		1	1					1	2		

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: Design for Manufacturing and Assembly

Course Code	**22MED74A**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3 : 0 : 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Manufacturing Process**,** Mechanical Measurements &Metrology**,** Strength of Materials

Course Objectives:

CLO1	Understand the concepts of Geometric dimensioning and Tolerances in Engineering Drawing
CLO2	Analyze the process capabilities and datum features in various components
CLO3	Evaluate the design considerations of casting, injection moulding, die casting and powder metallurgical components
CLO4	Estimate the assembly limits, machining sequence and process parameters

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Design for Manufacturing** Introduction: History of DFM, Design philosophy steps in Design process General Design rules for manufacturability basic principles of designing for economical production creativity in design. evaluation method, Process capability. Materials: Selection of Materials for design Developments in Material technology criteria For material selection.	**08 Hours / L3**
Module 2 Components design for Manufacturing **Component Design I**: Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, Simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly. **Component Design II:** Casting Consideration: Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, redesign of cast members to Obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA.	**08 Hours / L3**
Module 3: **Assembly** Assemble advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation.	**08 Hours / L3**

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Automatic assembly transfer systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator paced free – transfer machine. GD&T – Symbols, three datum concept of dimensioning, Straightness, concentricity, Runout, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples**.**	
Module 4 **Manual Assembly** Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time	**08 Hours / L3**
Module 5 **Design for Environment** Design for the Environment: Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standard.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO74A.1	Apply the concepts of Geometrical dimensioning, selection of materials and tolerance for engineering products
CO74A.2	Analyze the design principles related to various manufacturing processes and assembly method
CO74A.3	Develop the appropriate material and machining sequence for manufacturing processes
CO74A.4	Select a suitable manufacturing system considering environmental factors

Textbooks:

1. Designing for Manufacture, Peck H, Pitman Publications, 1983 O.P. Khanna.
2. Engineering Design: A Materials and processing Approach, Dieter, G.E. McGraw Hill Co.Ltd 2000
3. Engineering Metrology, R K Jain, Khanna Publications, 2000.

Reference books:

1. **ASM Hand book**, Vol.20. Material selection & Design
2. **Handbook of Products Design for Manufacturing**: A Practical Guide to Lowcost Production Bralla, James G. McGraw Hill, New York, 1986.
3. Product Design for Manufacture and Assembly, Geoffery Boothroyed et al, Mercel Dekker Inc. New

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E-Books / Web References

1. Design for Manufacturing- https://archive.nptel.ac.in/courses/107/103/107103012
2. Design Quality, Manufacturing & assembly- https://onlinecourses.nptel.ac.in/noc19_me48/preview
3. Product Design & manufacturing- https://onlinecourses.nptel.ac.in/noc21_me66/preview
4. Plastic properties and Processing- https://nptel.ac.in/courses/112107086/13

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO74A.1	3	2	1							1		1			3
CO74A.2	3	2	1							1		1			3
CO74A.3	3	2	1							1		1			3
CO74A.4	3	2	1							1		1			3
Average	3	2	1							1		1			3

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: THERMAL MANAGEMENT OF ELECTRONIC EQUIPMENT

Course Code	22MED74B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Heat Transfer

Course Objectives: Students will be taught:

CLO1	The semiconductor technology and the importance of thermal management in electronics
CLO2	Various thermal transfer process and properties of the surfaces affecting the thermal management
CLO3	Advanced cooling methodologies and thermal design
CLO4	To perform and analyze computer simulations for solution of real-world thermal management problems

Content	No. of Hours/ RBT levels
Module 1 **Introduction**: Semiconductor Technology Trends. Temperature –Dependent Failures, Importance of heat transfer in electronics. Thermal design process. Heat Transfer mechanisms, thermal resistance network.	**08 Hours / L1, L2, L3**
Module 2 **Heat Conduction Equation-Fins and Heat sinks Radiation Heat Transfer**: General heat Conduction equation. Boundary and initial conditions. Steady state, Transient heat, Micro scale heat conduction. Fin equation, Heat sinks, Blackbody radiation, Radiation heat transfer from plate-fin heat sinks, simple numericals.	**08 Hours / L1, L2, L3**
Module 3 **Convective Heat Transfer:** Velocity and thermal boundary layer. Friction coefficient, Heat transfer coefficient. External and Internal flows, Natural convection heat transfer, simple numericals.	**08 Hours / L1, L2, L3**
Module 4 **Advanced Cooling Technologies:** Experimental Techniques and Thermal design: Heat pipes, Heat pipe selection and modeling, Jet impingement on flat surfaces and heatsinks, Liquid immersion cooling, Thermo-syphons, Loop heat pipes, Thermoelectric coolers, cooling using phase change– cooling with PCM materials, piezoelectric fans, Electro hydrodynamic flow, Synthetic Jets, Single phase and two-phase flow micro channels-Thermal design.	**08 Hours / L1, L2, L3**
Module 5 **Temperature measurement:** Thermocouples, overview, reference junction, proper connections, types, special limits of error wire, time constants, sheathing, potential problems, DAQ setup	**08 Hours / L1, L2, L3**

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RTDs: overview, bridges, calibration, accuracy, response time, potential problems **Thermistors**: Infrared Thermometry fundamentals, emissivity determination, field of view, Other Non-electronic measurement, thin-film heat flux gauge Temperature Controllers How to Choose; Standards, cost, accuracy, stability, sensitivity, size, contact/non-contact, temperature range, fluid type **Thermal interface materials**, types, ideal and actual TIM, TIM test methods	

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO74B.1	Explain the need for thermal management in electronic components, devices and systems and application of thermal design to electronic equipments.
CO74B.2	Usage of fundamental heat transfer mechanisms to design efficient cooling of electronics components and systems and Illustrate the usefulness of the concept of thermal resistance.
CO74B.3	Carry out the analysis of convective heat transfer mechanisms from an electronic system
CO74B.4	Debate on introduction of advanced cooling technologies
CO74B.5	Review of the different temperature measurement equipment's and thermal interface materials

Textbooks:

1. **Shabany Younes** "Heat Transfer-Thermal Management in Electronics", CRC Press, First Edition, 2010
2. **Steinberg, Dave S., "Cooling Techniques for Electronic Equipment",** John Wiley & Sons, 1991
3. Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.

Reference books:

1. G N Ellison, Van Nostrand Reinhold, "Thermal Computations for Electronic Equipment", First Edition, 1984
2. A D Kraus and A Bar Cohen, "Thermal Analysis and Control of Electronic Equipment", McGraw-Hill, Hemisphere, Second Edition, 1983

E-Books / Web References

1. **https://www.pdfdrive.com/thermal-management-of-microelectronic-equipment-heat-transfer-theory-analysis-methods-and-design-practices-e185972760.html**
2. https://www.pdfdrive.com/heat-pipe-design-and-technology-modern-applications-for-practical-thermal-management-d176024584.html

MOOCs

1. NPTEL Course: "Electronic enclosures Thermal issues" (https://onlinecourses.nptel.ac.in/noc21_ee46/preview)
2. Free Video Lectures: "Thermal Design and Cooling", (https://www.youtube.com/watch?v=m7LVcog4bpc)

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO74B.1	3	2	1		1		1			1		1		1	
CO74B.2	3	2	1		1		1			1		1		1	
CO74B.3	3	2	1		1					1		1		1	
CO74B.4	3	2	1		1		1			1		1		1	
CO74B.5	3	2	1		1		1			1		1		1	
Average	3	2	1		1		1			1		1		1	

Low - 1: Medium - 2: High – 3

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SEMESTER – VI

Course: TOTAL QUALITY MANAGEMENT

Course Code	22MED74C	CIE Marks	50
Hours/Week (L: T: P)	3: 0: 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management & Entrepreneurship

Course Objectives: The students are taught to:

CLO1	Understand the various approaches to TQM and Quality management system.
CLO2	Explain The characteristics of quality leader and his role.
CLO3	Know the Develop feedback and suggestion systems for quality management.
CLO4	The knowledge in Tools and Techniques of quality management

Content	No. of Hours/ RBT levels
Module 1 **Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. **Quality Management Systems:** Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**08 Hours / L3**
Module 2 **Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.	**08 Hours / L3**
Module 3 **Customer Satisfaction and Customer Involvement:** Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. **Employee Involvement** – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**08 Hours / L3**
Module 4 **Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma. **Statistical Process Control:** Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	**08 Hours / L3**
Module 5 **Tools and Techniques:** Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance	**08 Hours / L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO74C.1	Evaluate various approaches to Total Quality Management (TQM) and analyze the standards and requirements of ISO 9000 and ISO 9001, including the benefits of implementing the ISO 9000 series.
CO74C.2	Assess the characteristics of quality leaders, effective individuals, and ethical considerations.
CO74C.3	Examine the importance of customer satisfaction and employee involvement through detailed case studies.
CO74C.4	Apply statistical tools for the continuous improvement of quality systems and evaluate their effectiveness in real-world scenarios.
CO74C.5	Implement tools and techniques for effective TQM and identify areas for quality improvement using Quality Function Deployment (QFD) and Failure Mode and Effects Analysis (FMEA).

Textbooks:

1. **Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education. (First Indian Reprints 2004).**
2. **Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002**

Reference books:

1. **M. Zairi, Total Quality Management for Engineers, Woodhead Publishing.**
2. **A New American TQM, four revolutions in management, ShojiShiba, Alan Graham, David Walden, Productivity press, Oregon.**
3. **100 Methods for Total Quality Management: Gopal K. Kanji and Mike Asher, ISBN: 0803977476, Publisher: Sage Publications, Inc.; Edition – 1**

E-Books / Web References

1. Gurus of TQM
   - https://www.focusstandards.org/quality-gurus-key-contributions
2. TQM Framework
   - https://www.emeraldinsight.com/doi/abs/10.1108/eb060192
3. Principles of TQM:
   - https://study.com/academy/lesson/five-principles-of-total-quality-managementtqm.html
4. Characteristics of quality leaders:
   - https://www.mechlectures.com/leadership-characteristics-quality-leaders/
   - https://www.briantracy.com/blog/leadership-success/the-sevenleadershipqualities-of-great-leaders-strategic-planning/
5. Customer Satisfaction and Customer Involvement
   - https://www.emeraldinsight.com/doi/abs/10.1108/17566691311316248
   - https://study.com/academy/lesson/consumer-involvement-in-the-decisionmakingprocess.html
6. **Statistical Process Control**
   - http://asq.org/learn-about-quality/seven-basic-quality-tools/overview/overview.html

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- https://www.whatissixsigma.net/7-qc-tools/

7. **Design for Six Sigma**
   - https://quality-one.com/six-sigma/

moocs:

1. 1. NPTEL Course: "Total Quality Management"
   https://archive.nptel.ac.in/courses/110/104/110104080/
2. NPTEL Course: "Total Quality Management"
   https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg34/

Scheme of Examination:
Semester End Examination (SEE):
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**
The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE):
Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO74C.1	**2**	1				1	1	1		1	3	2			2
CO74C.2	2	1				1	1	1		1	3	2			2
CO74C.3	2	1				1	1	1		1	3	2			2
CO74C.4	2	1				1	1	1		1	3	2			2
CO74C.5	2	1				1	1	1		1	3	2			2
Average	**2**	**1**				**1**	**1**	**1**		**1**	**3**	**2**			2

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: Automotive Engineering and Hybrid Vehicle technology

Course Code	22MED74D	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives: To enable students to apply the knowledge of materials and alloys by making them learn the:

CLO1	Relate the functions and importance of automotive parts and their performance
CLO2	Know the working of transmission and brake systems.
CLO3	Gain the knowledge of operation and working of steering and suspension systems.
CLO4	The concepts of various Injection system and its advancements.
CLO5	Understand the Hybrid Vehicle technology, Automobile emissions control techniques & the Norms

Content	No. of Hours/ RBT levels
Module 1 **ENGINE COMPONENTS AND IT'S PARTS**: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines. **COOLING AND LUBRICATION:** Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.	**08 Hours / L1, L2, L3**
Module 2 **FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES**: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburettors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System. **SUPERCHARGERS AND TURBOCHARGERS:** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.	**08 Hours / L1, L2, L3**
TRANSMISSION SYSTEMS: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive. **BRAKES**: Types of brakes, mechanical compressed air, vacuum, and hydraulic braking system construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems,	**08 Hours / L1, L2, L3**

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Module 4 **STEERING AND SUSPENSION SYSTEMS**: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. **IGNITION SYSTEM**: Battery Ignition system, Magneto Ignition system, electronic Ignition system	**08 Hours / L1, L2, L3**
Module 5 **HYBRID AND ELECTRIC VEHICLES** Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles. **AUTOMOTIVE EMISSION CONTROL SYSTEMS:** Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Euro I, II, III and IV norms, FAME Policy	**08 Hours / L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO74D.1	Analyze the functions and interactions of different automobile parts and lubrication systems to enhance vehicle performance and maintenance.
CO74D.2	Evaluate the selection and application of diverse fuels and injection systems to improve efficiency and environmental sustainability in automotive engineering.
CO74D.3	Assess transmission and braking systems to enhance vehicle safety and operational efficiency.
CO74D.4	Design advanced steering and suspension systems, evaluating their applications to improve vehicle handling and comfort

Textbooks:

1. Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011 2. Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.

Reference books:

1. Automobile Engineering, R. B. Gupta, Satya Prakashan,(4th Edition)
2. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd
3. Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing
4. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc

E-Books / Web References

1. E - Books: https://www.pdfdrive.com/automotive-engineering
2. E-Books: https://engineeringbookspdf.com/category/automobile-engineering-books/ 3. Web reference: https://pib.gov.in/newsite/PrintRelease.aspx?relid=191377

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MOOCs

1. NPTEL Course: "Fundamental of Automotive " https://nptel.ac.in/courses/107106088
2. NPTEL Course: "Injection systems" (https://nptel.ac.in/courses/112103262)
3. MOOC Course: "Braking system", (https://hypersonictech.in/automotive-brake-system/
4. MOOC Course: "Emission control", (https://www.mooc-list.com/tags/carbon-emissions)

Scheme of Examination: (Integrated courses)

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of two sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.

Note: The laboratory assessment would be restricted to only the CIE evaluation.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Quiz1/AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO74D.1	3	1	1			1	1					1	1		
CO74D.2	3	1	1			1	1					1	1		
CO74D.3	3	1	1			1	1					1	1		
CO74D.4	3	1	1			1	1					1	1		
Average	3	**1**	**2**			**1**	**1**					**1**	1		

Low - 1: Medium - 2: High - 3

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SEMESTER – VII

Open Elective - II

Course: Additive Manufacturing

Course Code	22MED75A	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	3

Prerequisites: Elements of Mechanical Engineering

Course Learning Objectives: The students will be taught.

CLO1	The classification and steps involved in Additive Manufacturing.
CLO2	The various techniques and applications of additive manufacturing.
CLO3	The various types of raw materials used in additive manufacturing process.
CLO4	The Process parameters and the common faults confronted in additive manufacturing equipment and process design.
CLO5	The post processing techniques involved in additive manufacturing.

Content	No. of Hours/ RBT Levels
Module 1 **Introduction:** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications. **CAD for Additive Manufacturing**: CAD Data formats, Data translation, Data loss, STL format. Printing Processes.	**8 Hours / L1, L2, L3**
Module 2 **Additive Manufacturing Techniques:** Fusion Deposition Modelling: Process, Process parameter, Process Selection for various applications. Introduction to Stereo-Lithography, LOM, SLS, SLM. **Additive Manufacturing Application Domains**: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools. Direct digital manufacturing.	**8 Hours / L1, L2, L3**
Module 3 **Materials:** Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material-Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials. Use of multiple materials in additive manufacturing.	**8 Hours / L1, L2, L3**
Module 4 **Additive Manufacturing Equipment:** Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design.	**8 Hours / L1, L2, L3**
Module 5 **Post Processing:** Requirement and Techniques, Product Quality: Inspection and testing, Defects and their causes.	**8 Hours / L1, L2, L3**

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LIST OF PRACTICALS

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured Counterpart.

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO75A.1	Synthesize complex CAD models for 3D printing, effectively manage CAD data interchange, and generate optimized .stl files for advanced additive manufacturing applications.
CO75A.2	Integrate the generic processes and working principles of additive manufacturing to innovate and enhance production methodologies.
CO75A.3	Justify the selection of specific materials for given applications, optimizing their properties and performance in additive manufacturing.
CO75A.4	Troubleshoot complex issues in 3D printing hardware, ensuring optimal operation and maintenance of advanced additive manufacturing systems.
CO75A.5	Implement advanced post-processing techniques and perform thorough inspections to identify and rectify defects in 3D printed parts, ensuring high-quality outputs.

Textbooks:

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer.
2. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, 2013.of Materials, 3rd Edition, CBS Publishers.

Reference books:

1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific.
3. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

E-Books / Web References

- https://www.nist.gov/additive-manufacturing
- https://www.metal-am.com/
- http://additivemanufacturing.com/basics/
- https://www.3dprintingindustry.com/

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MOOCs

• NPTEL Course: ''Fundamentals of Additive Manufacturing Technologies''
https://nptel.ac.in/courses/112103306
• NPTEL Course: "Rapid Manufacturing"
https://onlinecourses.nptel.ac.in/noc20_me50/preview
• MOOC Course: "Principle and development of additive manufacturing technologies",
(https://onlinecourses.nptel.ac.in/noc19_me47/preview)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for **40 marks each**. The average of the three tests are taken for Computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of Quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group Activity/Projects.

Typical Evaluation pattern for regular courses is shown in **Table 1**.

Table 1: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	AAT	**10**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping																
CO/PO	PO1	PO2	PO3 PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO75A.1	3	2	1	1	3	2	-	-	-	-	-	1	-	-	3	-
CO75A.2	3	2	1	1	-	2	-	-	-	-	-	1	-	-	3	-
CO75A.3	3	1	1	1	-	2	3	-	-	-	-	1	-	-	3	-
CO75A.4	3	2	1	1	-	2	-	-	-	-	-	1	-	-	3	-
CO75A.5	3	1	1	1	-	2	-	-	-	-	-	1	-	-	3	-
Average	3	2	1	1	3	2	3	-	-	-	-	1	-	-	3	-

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Open Elective - II

Course: Project & Operations Management

Course Code	22MED75B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Management and Entrepreneurship

Course Objectives: This course will enable the students to,

CLO1	To instill Project Management principles and practices to create/develop a unique product, a unique service or capability to perform a service, unique result, such as an outcome or document and/or a unique combination of one or more products, services or results.
CLO2	To inculcate the S.M.A.R.T deliverables of a project and evaluate the impact of these deliverables on the states of nature viz. economic, material, social, and environmental.
CLO3	To elucidate the benefits of Project Management and its applications on business value creation comprising tangible (Monetary assets, Stakeholder equity, Utilities and Market share etc.) and intangible elements (Strategic alignment, Goodwill and Brand recognition etc.).

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Project Management:** Understanding Project Management, Defining the Project Manager's Role, Defining the functional Manager's role, the project manager as the planning agent, Project Sponsor Interface, project Champions, Project Driven v/s Non-project Driven Organizations. Classifications of Projects, Differing views of Project Management, Concurrent Engineering: A project Management approach, informal Project Management Product v/s Project management, Project Life cycles, Many faces of failure.	**10 Hours /L3**
Module 2 **Planning:** Phases of Project Life Cycle: Initiating Process (Engineering Quote Process, The Project Award, Project with a Kick-off), Planning Process (Information Sharing, Development & Updating in Project Plan), Executing Process, Monitoring and Controlling Process and Closing Process. Scope Management: Development of Work Breakdown Structure (WBS) and Resources Management. Estimation of WBS effort.	**10 Hours /L3**
Module 3 **Network Scheduling Techniques:** Network Fundamentals, Slack time, Network planning, estimating total project time, Total PERT/CPM planning, Crashing of Networks, PERT/CPM Numericals.	**10 Hours /L3**

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Module 4 **Project Development Models:** Introduction and Comparison between Waterfall Methodology and Agile Methodology. Waterfall Model: Stages of Waterfall methodology (Requirements, Design, Implementation, verification or testing and Deployment & Maintenance), Prominent Uses of Waterfall Methodology, Advantages and Disadvantages of Waterfall Methodology. **Agile Methodology:** Overview, Agile Manifesto, 3C's of Agile (Card, Conversation and Confirmation), Benefits of Agile Model.	**10 Hours /L3**
Module 5 **Forecasting:** Nature and Use of Forecast, Forecasting Models and methods – Selection of Forecasting Techniques, measures of Forecasting accuracy, simple moving average, weighted moving average, double moving average, simple exponential smoothening, adjusted exponential smoothening, Linear regression method. **Inventory Control**: Inventory Decisions, Costs, Inventory Models.	**10 Hours /L3**

COURSE OUTCOMES: Upon completion of this course, students will be able to

CO75B.1	Recognize the significance of Project Management in complex business setups and describe an organized flow structure for effective accomplishment of predetermined objectives of organization.
CO75B.2	Understand the Project life cycle processes and construct appropriate action plan for optimizing resources of the underlying project deliverables.
CO75B.3	Apply the knowledge of construction of networks and the estimation of time of completion of the project
CO75B.4	Distinctively of elaborate the difference between the Waterfall Methodology and Agile Methodology and apply the appropriate Project development models
CO75B.5	Understand the costs and models of forecasting and inventory techniques.

Textbooks:

1. **Harold Kerzner:** Project Management - A Systems Approach to Planning, Scheduling, and Controlling, 10th edition.
2. A Guide to the Project Management Body of Knowledge – Project Management Institute.
3. **Kalpesh Asher:** Project Management and Agile Essentials – A Practical Self-Study Guide, Vibrant Publishers.
4. Pannerselvam, Production and Operations Management – Third Edition, PHI

Reference books:

1. **Mark C. Layton, Steven J. Ostermiller**: Agile Project Management for Dummies.
2. **Prasanna Chandra:** Project Management – Planning & Control, TMH.

E-Books / Web References

1. https://opentextbc.ca/projectmanagement/
2. https://pm-guide.netguru.com/

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MOOCs

1. https://www.edx.org/course/introduction-to-project-management?index=product&search_index=product&webview=false&campaign=Introduction+to+Project+Management&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fproject-management

Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40.

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible AATs: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	QUIZ/OAT	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO75B.1	2	3	3	3	2				2	2	3	2			
CO75B.2	2	3	3	3	2				2	2	3	2			
CO75B.3	2	3	3	3	2				2	2	3	2			
CO75B.4	2	3	3	3	2				2	2	3	2			
CO75B.5	2	3	3	3	2				2	2	3	2			
Average	**2**	**3**	**3**	**3**	**2**				**2**	**2**	**3**	**2**			

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

OPEN ELECTIVE - II

Course: Renewable Energy Power Plants

Course Code	22MED75C	CIE Marks	50
Hours/Week (L: T: P)	3: 0: 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Elements of Mechanical Engineering

Course Objectives:

CLO1	To explore society's present needs and future energy demands.
CLO2	To introduce the concepts of solar energy
CLO3	To introduce the concepts and applications of Wind energy, Biomass energy, geothermal energy and Ocean energy as alternative energy sources.
CLO4	To get exposed to energy conservation methods.

Content	No. of Hours/ RBT levels
Module 1 **Introduction to Renewable Energy:** Overview of global energy demand and the need for renewable energy, Comparison of renewable and nonrenewable energy sources, Environmental benefits and challenges of renewable energy. Solar Radiation: Extra Terrestrial radiation, spectral distribution of extraterrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation	**08 Hours / L3**
Module 2 **Solar Power Plants**: Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar Thermal Conversion: Collection and storage, thermal collection devices. Fundamentals of solar energy and photovoltaic (PV) technology, Types of solar power plants: grid tied, off grid, and hybrid systems, Design considerations for solar power plants: site selection, orientation, and shading analysis, PV system components and their functionalities, Operation, maintenance, and performance monitoring of solar power plants	**08 Hours / L3**
Module 3 **Wind Power Plants**: Basics of wind energy and wind turbine technology, Types of wind turbines: horizontal axis and vertical axis; Wind resource assessment and site selection for wind power plants, Wind farm layout optimization and wake effects, Grid integration and power system considerations for wind power plants Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.	**08 Hours / L3**

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Module 4 **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations. Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.	**08 Hours / L3**
Module 5 **Biomass Power Plants:** Biomass as a renewable energy source: types and characteristics, Conversion technologies: combustion, gasification, and anaerobic digestion, biomass feedstock selection and availability, Environmental impacts and sustainability of biomass power plants, Integration of biomass power plants with other energy systems **Hydrogen Energy:** Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos Chemical production biochemical production.	**08 Hours / L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO75C.1	Understand the need of renewable energy resources, historical and latest developments.
CO75C.2	Describe the use of solar energy and the various components used in the energy production
CO75C.3	Comprehend the functioning of the Lathe machine, drilling machine, and shaping machine.
CO75C.4	Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and Applications.
CO75C.5	Understand the concept of Biomass energy resources and their classification, types of biogas Plants applications

Textbooks:

1. Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2. Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solar energy, Subhas P Sukhatme, TataMcGrawHill, 2ndEdition,1996

Reference books:

1. Principles of Energy conversion, A.W.Culp Jr. McGraw Hill, 1996
2. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018

E-Books / Web References

1. Internet energy- https://www.investopedia.com/terms/i/internetenergy
2. Renewable energy sources - https://www.pdfdrive.com/nonconventionalenergysourcese10086374.
3. E book URL: https://www.pdfdrive.com/nonconventionalenergysystemsnpteld17376903
4. Ebook URL: https://www.pdfdrive.com/renewableenergysourcesandtheirapplicationse33423592
5. Ebook URL: https://www.pdfdrive.com/lecturenotesonrenewableenergysourcese34339149
6. html https://onlinecourses.nptel.ac.in/noc18_ge09/preview

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Scheme of Examination: (Theory courses)

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE on a scale of 40. The assignment would be for a total of 10 marks,

CIE is executed by way of two quizzes / Other Assessment Tools (OATs), and three tests.

Some possible methods of assessment for assignments: Assignments / Oral presentations / Group activity/Projects

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Integrated courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
		Grand Total	**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO75C.1	3	2					1					1			3
CO75C.2	3	2					1					1			3
CO75C.3	3	2					1					1			3
CO75C.4	3	2					1					1			3
CO75C.5	3	2					1					1			3
Average	3	2					1					1			3

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: Major Project Phase II

Course Code	22MEDP76	CIE Marks	100
Hours/Week (L: T: P)	0 : 0 : 12	SEE Marks	100
No. of Credits	06	Examination Hours	03

CIE for Project Phase - II:

1. **Single discipline:** The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates using Rubrics.

2. **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes.

SEE for Project Phase - II:

1. **Single discipline:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
2. **Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Review-II	50	100
	Review-III	50	
SEE		100	100
Grand Total			200

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SEMESTER – VII

Course: DESIGN Laboratory

Course Code	22MEDL77	CIE Marks	50
Hours/Week (L: T: P)	0 : 0 : 2	SEE Marks	50
No. of Credits	1	Examination Hours	03

Prerequisites: Strength of materials, Mechanical Vibrations, Theory of machines

Course Objectives: The students will be taught to :

CLO1	Demonstrate the concepts discussed in Mechanical Vibrations & Dynamics of Machines courses.
CLO2	Visualize and understand the development of stresses in structural members and experimental determination of stresses in members utilizing the optical method of reflected photoelasticity.

Content	No. of Hours/ RBT levels
Part-A 1. Determination of natural frequency of a spring mass system. 2. Determination of natural frequency logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional). 3. Determination of critical speed of rotating shaft. 4. Balancing of rotating masses.	**14** **L1, L2, L3**
Part-B 5. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four-point bending) 6. Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes. 7. Determination of equilibrium speed, sensitiveness, power, and effort of Porter/Watt Governor. 8. Determination of pressure distribution in Journal bearing 9. Experiments on Gyroscope (Demonstration only)	**14** **L1, L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO77.**1**	Understand the working principles of machine elements such as Governors, Gyroscopes etc.
CO77.**2**	Identify forces and couples in rotating mechanical system components.
CO77.**3**	Identify vibrations in machine elements and design appropriate damping methods and to determine the critical speed of a rotating shaft.
CO77.**4**	Measure strain in various machine elements using strain gauges.
CO77.**5**	Determine the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing
CO77.**6**	Determine strain induced in a structural member using the principle of photo-elasticity.

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Reference books:

1. "Shigley"s Mechanical Engineering Design", Richards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.
2. "Design of Machine Elements", V.B. Bhandari, TMH publishing company Ltd. New Delhi, 2nd Edition 2007.
3. "Theory of Machines", Sadhu Singh, Pearson Education, 2nd Edition, 2007.
4. "Mechanical Vibrations", G.K. Grover, Nem Chandand Bros, 6th Edition, 1996.

E-Books / Web References

1. https://www.youtube.com/watch?v=Ujtv5NY4Sq8&list=PL21BB25670CDC2AEB

Vibration simulation videos

1. https://www.youtube.com/watch?v=qcHjDLCJxfI
2. https://www.youtube.com/watch?v=Vj1xmze3GlE
3. https://www.youtube.com/watch?v=-BPbfRX4j0A

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be reduced to 50.

Continuous Internal Evaluation (CIE): Weekly Performance – Lab participation and report will be evaluated for 30 Marks and one Internal assessment is conducted at the end of semester for 20 Marks.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	Weekly Performance – Lab participation and report	**30**	**50**
	One IA at the end of semester	**20**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO77.**1**	2	1	1	1		1	1	2	3	3		1	2		
CO77.**2**	2	1	1	1		1	1	2	3	3		1	2		
CO77.**3**	2	1	1	1		1	1	2	3	3		1	2		
CO77.**4**	2	1	1	1		1	1	2	3	3		1	2		
CO77.**5**	2	1	1	1		1	1	2	3	3		1	2		
CO77.**6**	2	1	1	1		1	1	2	3	3		1	2		
Average	**2**	**1**	**1**	**1**		**1**	**1**	**2**	**3**	**3**		**1**	**2**		

Low - 1: Medium - 2: High – 3

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SEMESTER – VII

Course: Energy Engineering Laboratory

Subject Code	**22MEDL78**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to,

CLO1	Determine the flash point & fire point, viscosity of lubricating oil and caloric value of all types fuels and lubricating oils.
CLO2	Conduct experiments on IC engines, understand its performance and draw the characteristic curves.
CLO3	Draw valve timing diagrams for IC engines.
CLO4	Determine the calorific value of all types of fuels.

Sl. No.	**Experiments**	**No. of Hours/ RBT levels**
	Part- A	
1	Lab layout, calibration of instruments and standards to be discussed	**02 Hours / L3**
2	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's Pensky Apparatus.	**02 Hours / L3**
3	Determination of Calorific value of solid, liquid and gaseous fuels.	**02 Hours / L3**
4	Determination of Viscosity of a lubricating oil using Redwoods, Saybolt and Torsion Viscometers.	**02 Hours / L3**
5	Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples	**02 Hours / L3**
6	Valve Timing/port opening diagram of an I.C. Engine.	**02 Hours / L3**
	Part - B	
7	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine e. Variable Compression Ratio I.C. Engine.	**10 Hours / L3**
8	Measurements of Exhaust Emissions of Petrol engine.	**02 Hours / L3**
9	Measurements of Exhaust Emissions of Diesel engine.	**02 Hours / L3**
Demonstration:		
1	Visit to Automobile Industry/service stations.	**01 Hours / L2**

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Course Outcomes: Upon successful completion of this course, student will be able to:

CO78.1	Evaluate the viscosity, flash point, fire point of fuels
CO78.2	Determine the quality of Engine fuels by analyzing its calorific value.
CO78.3	Determine the actual valve timing for I C Engine and draw the diagram.
CO78.4	Analyze the various performance parameters at different operating conditions of an IC Engine
CO78.5	Estimate the constituents of combustion products for emission characteristics related to public safety.

Textbooks:

1. C. Engines by V.Ganeshan, Tata McGraw Hill
2. I. C. Engines by Domkundwar & Domkundwar, Dhanpatrai
3. I. C. Engines by R.K.Rajput, Laxmi Prakashan
4. I. C. Engines by R. Yadav, Central Pub., Allahabad

References:

1. I.C. Engines by Heywood.
2. IC. Engines by Mathur & Sharma, Dhanpatrai

Scheme of Examination:

Semester End Examination (SEE):

	Component	Marks	Marks	Total Marks
SEE	PART- A	**30**	**100**	**50**
	PART- B	**50**		
	VIVA-VOCE	**20**		
			SEE Total	**50**

Continuous Internal Evaluation (CIE):

	Component	Marks	Total Marks
CIE	MANUAL / RECORD	**20**	**50**
	CIE Test	**20**	
	VIVA-VOCE	**10**	
		CIE Total	**50**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO78.1	3	1	1	2			1		1	2		1		3	
CO78.2	3	1	1	2			1		1	2		1		3	
CO78.3	3	1	1	2			1		1	2		1		3	
CO78.4	3	1	1	2			1		1	2		1		3	
CO78.5	3	1	1	2			1		1	2		1		3	
Average	**3**	**1**	**1**	**2**			**1**		**1**	**2**		**1**		**3**	

Low - 1: Medium - 2: High – 3

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VIII SEMESTER

SYLLABUS

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SEMESTER – VIII
Professional Elective – IV (Online Courses)

Course: Quality Design & Control

Course Code	22MED81A	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Nil

Course Objectives:

The objective of the course is to introduce basic concepts and statistical methods employed for assurance of quality in products, processes and systems in an industrial environment (manufacturing and service organizations), such as Management and Control of Quality and Quality System, Statistical Process Control, Process Capability Analysis, Acceptance Sampling, Process Capability Analysis, Design for Reliability, Robust Design and Taguchi Method for Quality Improvement.

Course Content

Week 1: History and Evolution of Quality Control and Management
Week 2: Management of Quality-I
Week 3: Management of Quality-II
Week 4: Statistical Process Control-I
Week 5: Statistical Process Control-II
Week 6: Process Capability Analysis
Week 7: Acceptance Sampling-I
Week 8: Acceptance Sampling-II
Week 9: Design for Reliability-I
Week 10: Design for Reliability-II
Week 11: Quality by Experimental Design
Week 12: Robust Design and Taguchi Method

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO81A.1	Understanding the Quality Principles for effective quality management
CO81A.2	Understanding the Statistical Process to monitor and control a process
CO81A.3	Understanding the Process Capability Analysis and Acceptance Sampling to ensure products and processes meet quality standards
CO81A.4	Understanding the Design for Reliability to meet performance standards under expected operating conditions
CO81A.5	Understanding the Quality by Experimental Design to identify the effects of multiple variables.

Textbooks:

1. Mitra, A. Fundamentals of Quality Control and Improvement, Prentice-Hall, 2nd Edn .(1998), ISBN: 0-13-645086-5.

2. Dukkipati, R V and Pradip K Ray, Product and Process Design for Quality, Economy and Reliability, New Age International. 1st Edn. (2010), ISBN: 978-81-224-2661-8.

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E-Books / Web References

https://onlinecourses.nptel.ac.in/noc21_mg24/preview

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs:

Assignments/ oral presentation/ group activity / projects /any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO81A.1	1	1	1		1			1		1		1	2		
CO81A.2	1	1	1		1			1		1		1	2		
CO81A.3	1	1	1		1			1		1		1	2		
CO81A.4	1	1	1		1			1		1		1	2		
CO81A.5	1	1	1		1			1		1		1	2		
Average	1	1	1		1			1		1		1	2		

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

Professional Elective – IV (Online Courses)

Course: Product Design and Manufacturing

Course Code	22MED81B	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Manufacturing Process.

Course Objectives:

Designing goods that meet or beyond consumer expectations in terms of usability, functionality, and beauty under a range of operating settings is the course's goal. Make designs that are simple and affordable to produce, build, and test.

Course Content

Week 1 : Introduction to product design and manufacturing
Week 2 : Product design morphology
Week 3 : Visual Design, and Quality Function Deployment (QFD)
Week 4 : Value Engineering
Week 5 : Material, and Manufacturing process selection
Week 6 : Design for Manufacturing, Assembly, and Maintenance
Week 7 : Design for Environment, and Quality Control
Week 8 : Patenting, and Creativity
Week 9 : Rapid Prototyping
Week 10 : Plant Layout Design
Week 11 : Computer Integrated Manufacturing
Week 12 : Reverse Engineering, and Managing Competitiveness

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO81B.1	Understanding the Product design morphology to ensure that a product meets the expectations
CO81B.2	Understanding Quality Function Deployment (QFD) and Value Engineering used to improve quality, reduce costs, and enhance value.
CO81B.3	Understanding the concept of **Design for X"** principles of product design and development process.
CO81B.4	Understanding the concept of Patent and Creativity in product development.
CO81B.5	Understanding the modern manufacturing and product development like Rapid Prototyping, Computer Integrated Manufacturing and Reverse Engineering

Textbooks:

- Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education

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- Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press.
- Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520.

E-Books / Web References

Product Design and Manufacturing - Course (nptel.ac.in)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs:

Assignments/ oral presentation/ group activity / projects /any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO81B.1	1	1	1		1			1		1		1	2		
CO81B.2	1	1	1		1			1		1		1	2		
CO81B.3	1	1	1		1			1		1		1	2		
CO81B.4	1	1	1		1			1		1		1	2		
CO81B.5	1	1	1		1			1		1		1	2		
Average	1	1	1		1			1		1		1	2		

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

Professional Elective – IV (Online Courses)

Course: Machinery Fault Diagnosis and Signal Processing

Course Code	22MED81C	CIE Marks	50
Hours/Week (L: T: P)	3 : 0 : 0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Prerequisites: Manufacturing Process.

Course Objectives:

To provide with the state of the art techniques in machinery condition monitoring along with the recent developments in the field of signal processing, thermography, ultrasonic apart from the traditional noise and vibration monitoring.

Course Content

Week 1: Maintenance Principles, FMECA, Fault Prognosis
Week 2: Vibration Analysis, Experimental Modal Analysis, Rotor Dynamics
Week 3: Time domain Signal analysis, Data Acquisition, Filtering
Week 4: Fourier Series, FFT, Modulation and Sidebands
Week 5: Order Analysis, Orbits
Week 6: Instrumentation, Data Recording
Week 7: Vibration and Noise Monitoring
Week 8: Rotating Machines, Bearings and Gears
Week 9: Fans, Blowers, Pumps, IC Engines
Week 10: Motor Current Signature Analysis, Wear Debris and Oil Analysis
Week 11: NDT, Ultra-sonics, Eddy Current
Week 12: Case Studies, Failure Analysis

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO81C.1	Understanding the techniques essential for ensuring the reliability, performance, and safety of mechanical systems and machinery
CO81C.2	Understanding the fundamental techniques and concepts in signal processing
CO81C.3	Understanding the concept of vibration and noise monitoring used for different types of machinery
CO81C.4	Understanding the concept of Motor Current Signature Analysis, Wear Debris and Oil Analysis to assess the health of machinery and equipment.
CO81C.5	Understanding the concept of NDT including Ultra-sonics and Eddy Current

Textbooks:

- Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education
- Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press.

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- Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520.

E-Books / Web References

Machinery Fault Diagnosis and Signal Processing - Course (nptel.ac.in)

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible AATs:

Assignments/ oral presentation/ group activity / projects /any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO81C.1	1	1	1		1			1		1		1	2		
CO81C.2	1	1	1		1			1		1		1	2		
CO81C.3	1	1	1		1			1		1		1	2		
CO81C.4	1	1	1		1			1		1		1	2		
CO81C.5	1	1	1		1			1		1		1	2		
Average	1	1	1		1			1		1		1	2		

Low - 1: Medium - 2: High – 3

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Bangalore - 98

SEMESTER – VIII

Professional Elective – IV (Online Courses)

Course: Computer Integrated Manufacturing

Course Code	**22MED81D**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**03**	**Examination Hours**	**03**

Course Objectives: This course will enable the students to

CLO1	Impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models
CLO2	Make students to understand Computer graphics and Transformations.
CLO3	Get Exposed to CNC Machine Tools, CNC part programming and CNC machine elements
CLO4	Get Exposed to computer aided process planning, assembly & Flexible Manufacturing Systems.
CLO5	Become aware of Robot anatomy and its attributes.

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Introduction to CIM, Definition, Dataflow in CIM, Processes involved, Need for CIM, Benefits & usages, Challenges , sub systems in CIM, Advantages of CIM, CIM Integration, Present scenario, Future prospects, Production systems**,** Automation in production systems, Manual labour in production systems, Automation principles & strategies, Reasons for Automation, Automation Migration strategy. Glossary of the terms used in CIM	**8 Hours / L1,L2, L3**
Module 2 **Computer Graphics:** Introduction, Computer Aided design Process, Popular Design Approaches, , Generic CAD process, major Benefits of CAD. Computer graphics Display, random scan display, raster scan display, Co-ordinate systems in CAD, Graphics pipeline. **Transformations of geometry**: Translation, Scaling, Rotation, Reflection or Mirror, Numericals. Homogeneous representation, Concatenated transformations, Colour Models, Curve Representation,	**8 Hours / L1,L2, L3**
Module 3 **Computer geometric modelling**,: Steps in creating the model, Functions of geometric Modelling, Wireframe modelling, Geometric construction methods, **Numerical Control**: Basic components of NC System, Advantages,, Disadvantages and applications of NC, Difference between NC & CNC. Types of CNC Machine. Lead screws, Feedback devices, Interpolation methods.CNC Machining center(Turning &	**8 Hours / L1,L2, L3**

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Milling center), CNC part programming, Manual part programming, List of CAM softwares.	
Module 4 **Process planning**: Group Technology, Benefits of group technology, Part family, coding systems, Limitations of group technology, Process planning, Production planning Computer aided process planning variant and generative types, Hybrid CAPP systems, **Flexible Manufacturing Systems**: Introduction, Types of FMS, Components of FMS, Types of FMS layouts, FMS computer functions, FMS applications,FMS Benefits,	**8 Hours / L1,L2, L3**
Module 5 **Industrial Robotics:** Robot anatomy & related attributes, Types of Joints, Types of robot configurations, Degrees of freedom, Types of drives, Sensors in robotics, Robot control systems, End effectors, Applications of Industrial robots, Robot programming, Robot accuracy & repeatability **PLC:** Major components of PLC, Various input output modules, Types of Memory in PLC, Working of PLC, ladder logic Diagrams,	**8 Hours / L1,L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO81D.1	Describe types of production systems and types of automation used in CIM
CO81D.2	Analyze the computer aided design process and transformations used in CIM.
CO81D.3	Illustrate the steps involved in geometric modelling and carry out CNC part programming.
CO81D.4	Explain the applications of computers in process planning (CAPP) and Flexible manufacturing systems.
CO81D.5	Apply the principles of robot anatomy, configurations to optimize the precision and efficiency of robotic movements in industrial applications

Textbooks:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.

2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hil

Reference books:

1. CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. Industry 4.0: The Industrial Internet of Things, Apress, 2017, by Alasdair Gilchrist
3. Computer Integrated Manufacturing by James A. Rehg, Henry W Kraebber , Pearson, 3rd Edition, 2017

E-Books / Web References

1. https://freevideolectures.com/course/3193/advanced-manufacturing-processes
2. https://freevideolectures.com/course/2367/industrial-engineering
3. https://freevideolectures.com/course/2367/industrial-engineering/24
4. https://freevideolectures.com/course/2367/industrial-engineering/27
5. https://freevideolectures.com/course/2367/industrial-engineering/28
6. https://freevideolectures.com/course/2367/industrial-engineering/36
7. https://freevideolectures.com/course/2367/industrial-engineering/37

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MOOCs

1. https://onlinecourses.nptel.ac.in/noc22_me10/preview
2. https://www.classcentral.com/course/swayam-computer-integrated-manufacturing-17550

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO81D.1	3	2	2	-	-	-	-	-	2	-	2	1	2	-	3
CO81D.2	3	2	2	-	-	-	-	-	-	-	-	1	2	-	3
CO81D.3	3	2	2	-	2	-	-	-	-	-	-	1	2	-	3
CO81D.4	3	2	2	-	-	-	-	-	-	-	-	1	2	-	3
CO81D.5	3	2	2	-	2	1	-	-	1	-	1	1	2	-	3
Average	3	2	2	-	2	1	-	-	1	-	2	1	2	-	3

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

OPEN ELECTIVE – III (Online Courses)

Course: FUNDAMENTALS OF AUTOMOTIVE SYSTEMS

Course Code	22MED82A	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Impart knowledge of Internal combustion engines and its components
CLO2	Understand the concepts of engine performance and supercharging
CLO3	Understand the principle of fuel system and emissions in automobiles
CLO4	Describe the working of transmission and brake systems
CLO5	Understand the operation and working of steering and suspension systems.

Content	No. of Hours/ RBT levels
Module 1 **ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS:** Classification of Internal Combustion Engines, Engine components – cylinder block, Cylinder Sleeves/Inserts, piston assembly, crankshaft, cylinder head, manifolds, valve assembly, camshaft, rocker arm. **Operation of four stroke engines**-Construction of four stroke S.I engine, two stroke engine, engine cycles- Otto Cycle and Diesel Cycle, Dual Cycle. Knocking in S I engines.	**8 Hours / L1,L2, L3**
Module 2 **Engine Performance:** Indicated power, Indicated Thermal Efficiency, Brake Thermal Efficiency, Mechanical Efficiency, Relative Efficiency, Volumetric Efficiency, Mean Effective Pressure, Mean piston speed, Specific power output, Specific fuel consumption. **Supercharging and Combustion in CI Engines**: Definition, working principle, benefits of Supercharging, Turbocharger, turbo charger circuit. Stages of Combustion in CI Engines, combustion with detonation, Knocking of CI Engines, Air-Fuel Ratio.	**8 Hours / L1,L2, L3**
Module 3 **Fuel Systems**: Carburetor- Construction of Simple Carburetor, Analysis of carburetor, Mixing of Air and Fuel in Carburetor. **Engine Emissions:** Engine exhaust emissions, Emissions in SI Engines, Emission Control Systems.	**8 Hours / L1,L2, L3**

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Module 4 **Automotive Power Train**: Clutch and its types, Transmission types, Power train analysis, transmission matching, **Braking Systems**: Components of Braking system, Types-Drum Brake, disc Brake, Hydraulic brake system, Air Brake system, Antilock Braking system.	**8 Hours / L1,L2, L3**
Module 5 **Steering System:** Classification-Manual steering system, power steering, kinematic steering, wheel alignment and Tyre components and wear. **Suspension system**: Introduction, types of suspension systems, shock absorbers, Independent and dependant suspension. **Introduction to Electric and Hybrid power train:** Classification of power train, types of electric and hybrid power trains.	**8 Hours / L1,L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO82A.**1**	Identify various components and types of I.C. engines.
CO82A.**2**	Analyze the engine performance and the stages involved in combustion.
CO82A.**3**	Analyse the working of carburetor and exhaust emissions in automobiles.
CO82A.**4**	Enumerate the working of transmission and braking systems in automobiles.
CO82A.**5**	Identify the functioning of steering, suspension systems and hybrid power train.

Textbooks:

1. Fundamentals of Automotive systems- C.S. Shankar Ram, IIT Madras.

2. Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers.

Reference books:

1. William H Crouse & Donald L Anglin- Automotive mechanics, Tata McGraw Hill Publishing Company.
2. Joseph Heitner, D Van Nostrand- Automotive mechanics: Principles and Practices
3. K.K.Ramalingam- Fundamentals of Automobile Engineering, Scitech Publications

E-Books / Web References

1.https://archive.nptel.ac.in/courses/107/106/107106088/

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

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Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO82A.**1**	3	2										1			3
CO82A.**2**	3	2										1			3
CO82A.**3**	3	2										1			3
CO82A.**4**	3	2										1			3
CO82A.**5**	3	2										1			3
Average	3	2										1			3

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

OPEN ELECTIVE – III (Online Courses)

Course: Industrial Safety Engineering

Course Code	22MED82B	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Provide comprehensive understanding of industrial safety management by examining key concepts related to major industrial accidents, safety and health issues, stakeholder responsibilities, and accident causation models.
CLO2	Develop a foundational understanding of FMEA, its purpose in reliability engineering, and its importance in identifying potential failure modes and their consequences within systems and processes..
CLO3	Gain a comprehensive understanding of the bow-tie method as a tool for visualizing the relationship between potential hazards, safety barriers, and control measures.
CLO4	Equip students with the skills and knowledge to evaluate and rank design solutions using structured decision-making tools, with a focus on the Analytical Hierarchy Process (AHP).
CLO5	provide students with the knowledge and tools necessary to quantify system safety using structured approaches, with a focus on analyzing simple systems, understanding reliability block diagrams, and addressing human error..

Content	No. of Hours/ RBT levels
Module 1 **Introduction:** Introduction, Major Industrial Accidents, Safety & health issues,Stake holders, Accident causation Model, Basic terminologies, Hazard theory,hazard triangle, Individual & societal risks, Risk perception, Acceptable risk, Common features of plants with high risks, taxonomy of negative interactions, Preliminary hazard list,PHL Overview, hazardous energy sources,cases, Hazard control Hierarchy, Preliminary hazard analysis, hazard and operability study.	**8 Hours / L1,L2, L3**
Module 2 **Failure Modes and Effects Analysis**, Methodology, An example, Topdown approach, Probability, Effects, Detectability, FMEA Documentation, Application of hazard identification techniques, safety ontology,Accident paths, Fault tree analysis, P-S-C Concept, Cut-set method, MOCUS algorithm, Event tree analysis, Quantification, Example, Bowtie tool & Management, Examples, Coupling mechanisms, Common cause cut sets. Fault tree linking along accident sequence.	**8 Hours / L1,L2, L3**
Module 3 **Safety barriers**: Identification of safety barriers,Bow-tie generic representation, safety barriers, Risk assessment process, Societal risk assessment, Consequence assessment, Identification and classification of losses, categories of losses, Energy	**8 Hours / L1,L2, L3**

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Control Model and Hazard Control Hierarchy, Safety Function Deployment, steps in SFD.	
Module 4 **Ranking of Design Solutions: AHP Approach**, Framework for evaluating design solutions, Development of comparison matrices, Steps for AHP, Ranking of design solutions, Quantification of Basic Events for Non – repairable Components, Reliability and failure distribution, failure density function, failure rate, Bathtub curve, Quantification of Basic Events – Exponential Distribution, Weibull Distribution, Repair distribution and repair density and repair rate, Definitions, Availability & unavailalability, Failure and repair intensities, Computation of combined process parameters Laplace transform analysis, Computation of combined process parameters Markov Analysis.	**8 Hours / L1,L2, L3**
Module 5 **Systems Safety Quantification**: Truth Table Approach, Smple systems, Reliability block Diagram, Minimal Cut and Minimal Path Representation using Structure Function, Structure Function, Human Error, Classification and Causes, Human error identification, Action error mode analysis, Human Reliability Assessment, Steps of HRA, HRA Methods, THERP, HEART, Human Error Quantification from Expert's opinions - Fuzzy Set Approach	**8 Hours / L1,L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO82B.1	Analyze major industrial accidents & Evaluate safety and health issues in industrial settings
CO82B.2	Understand the principles of Failure Modes and Effects Analysis (FMEA)
CO82B.3	Critically evaluate various types of safety barriers (e.g., physical, procedural, and human) in industrial and organizational contexts.
CO82B.4	Understand the principles of the Analytic Hierarchy Process (AHP) & Formulate decision hierarchies for design problem-solving
CO82B.5	Evaluate system reliability and failure probabilities through quantification methods

Textbooks:

1. Industrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102
2. Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003,The University of alberta press,Canada, ISBN: 0888643942.2. Industry 4.0: The Industrial Internet of Things, Apress, 2017, by Alasdair Gilchrist

Reference books:

1. Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X.
2. Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina,Lulu publication, ISBN:1291187235.

Scheme of Examination:
Semester End Examination (SEE):

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SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO82B.1	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1
CO82B.2	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1
CO82B.3	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1
CO82B.4	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1
CO82B.5	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1
Average	3	2	2	-	-	2	1	-	1	-	-	1	-	-	1

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

OPEN ELECTIVE – III (Online Courses)

Course: Strategies for Sustainable Design

Course Code	22MED82C	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Impart knowledge of sustainability in design & climate change mitigation.
CLO2	Understand the current scenario of sustainable design and impact of pollutions on health.
CLO3	Understand the environmental Impact and guidelines for building design.
CLO4	Identify the proper system design tool and need for Innovation in design process.
CLO5	Describe the emerging technologies and their possible Intervention in design.

Content	No. of Hours/ RBT levels
Module 1 **Perspectives on Sustainability in Industrial Design and Built Environments:** Definition, Perspectives around Sustainability in Design, Spheres of Energy Efficient/Green/Environmental/Sustainable Designs. **ESE Aspects of Sustainability and Climate Change Mitigation**- Environmental Sustainability, Social Sustainability, Economic Sustainability, Climate Change Mitigation and the Way Forward, Future of Human Habitation Design.	**8 Hours / L1,L2, L3**
Module 2 **Current National and International Scenario of SD and Dependence on Energy:** Relevance of Sustainable Design in Contemporary Context, Built Environment and Energy Consumption, Reliance and Dependence of Building Design on Energy, Current Scenario of Sustainable Design: Indian & International. **Impact of Pollutions and Design Processes with Alternative Solutions for Health of Ecosystem**: Designing Strategically for Preventing Pollution: Air, Water, Soil, Noise, Light, Radiation, etc. Low Environmental Impact, Thinking for Alternatives through Systemic Design, Consumption and Consumerist Lifestyle.	**8 Hours / L1,L2, L3**
Module 3 **Environmental Impact Assessment and Lifecycle Analysis**: Environmental Impact Assessment, Lifecycle Analysis. Policy, Growth, Development and 3R's for Consumption: Growth and Development in Construction and Allied Sectors,	**8 Hours / L1,L2, L3**

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Policy Push in Real Estate and Manufacturing Sectors, Sustainable Building Materials, Reduce/Reuse/Recycle **NBC, ECBC, and SA Methods such as GRIHA and LEED:** National Building Code 2016 - Part 11 and Energy Conservation building code, Guidelines for Building Design by SA Methods: GRIHA.	
Module 4 **UN SDG and System Design tools such as SPSS, MSDS by LeNS**: UN SDG for Sustainable Development, LeNS Design Method and Tools such as SPSS, MSDS & DE. **Vernacular and Responsive Design**: Vernacular Design Case Examples, Climate Responsiveness, Thinking the Unthinkable: Need for Innovation in Design Process, Design for Net-Zero Energy, Lighting, Ventilation, Views and Human comfort.	**8 Hours / L1,L2, L3**
Module 5 **Design for Sustainability and Nature as Inspiration:** D4S with inspiration from nature, D4S for optimisation of Manufacturing. **International Conventions, Laws and Emerging Technologies for SD**: International Conventions and Agreements Environmental Laws, Emerging Technologies and their Possible Intervention in Design. **SD Case Studies:** Campus Planning and Design of IIT Gandhinagar, A Comparative Analysis of Product Designs, Design of First Net-Zero Building of India.	**8 Hours / L1,L2, L3**

COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO82C.1	Identify sustainability in Industrial design and built environments for future of human habitation design.
CO82C.2	Analyze the current scenario of sustainable design and impact of pollutions and alternate solutions.
CO82C.3	Analyse the life cycle and environmental impact on sustainable building development.
CO82C.4	Select the design method tool for better innovation in design process.
CO82C.5	Identify the emerging technologies and their possible intervention in design.

Textbooks:

1. Strategies for Sustainable Architecture- Paola Sassi, by Taylor & Francis Inc.
2. Product Design and Sustainability, Strategies, Tools and Practice by Jane Penty.

Reference books:

1. Sustainable Design Strategies, by Raj Barr-Kumar, Environmental Design Technology Group .
2. Design for Environmental Sustainability, by Carlo Arnaldo Vezzoli, Ezio Manzini, Springer Science.

E-Books / Web References

1. https://onlinecourses.nptel.ac.in/noc21_de07/preview
2. https://archive.nptel.ac.in/courses/124/106/124106157/

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Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE. The assignment component would be for 10 marks. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

Some possible methods of assessment for assignments: Assignments/ Oral presentations / Group activity/Projects.

Typical Evaluation pattern for regular courses is shown in Table 2.

Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO82C.1	3	2										1			
CO82C.2	3	2										1			
CO82C.3	3	2										1			
CO82C.4	3	2										1			
CO82C.5	3	2										1			
Average	3	2										1			

Low - 1: Medium - 2: High – 3

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SEMESTER – VIII

OPEN ELECTIVE – III (Online Courses)

Course: Business Planning & Project Management

Course Code	22MED82D	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	03	Examination Hours	03

Course Objectives: This course will enable the students to

CLO1	Understand the concept of Planning and its importance for Businesses.
CLO2	Understand the concept of Project and importance of its management.
CLO3	Critically examine which project needs to be undertaken using various models
CLO4	Understand the importance of human resources for the projects
CLO5	Learn the concept of project audit, project life cycle and project termination process.

Content	No. of Hours/ RBT levels
Module 1 Planning- Introduction, Nature, Significance and Limitations of Planning, Planning Process, Planning Devices & Obstacles in Planning. Techniques of Forecasting- Introduction and Process of Forecasting, Techniques of Forecasting, Difference between Forecasting and Planning.	**8 Hours / L1,L2, L3**
Module 2 Introduction to Project Management, Project Management Maturity, Project Selection -Model & Types. Project Management and Project Manager, Organisation Structures for Project Management.	**8 Hours / L1,L2, L3**
Module 3 Project Organisation and Matrix Organisation, The Nature of Negotiation, Conflict and Project Life Cycle, PERT and CPM, Critical Path Method & Crashing the Project control.	**8 Hours / L1,L2, L3**
Module 4 The Planning - Monitoring - Controlling Cycle. Fundamental Purposes of Project Control, Overview of project controls, Design of Control Systems, control as a function of management.	**8 Hours / L1,L2, L3**
Module 5 Project Audit, Audit policies and activation procedures, The audit lifecycle, Project Audit Report, Some Essentials of an Audit, Varieties of Project Termination, Termination Process.	**8 Hours / L1,L2, L3**

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COURSE OUTCOMES: Upon completion of this course, student will be able to:

CO82D**.1**	Identify the significance of business planning and techniques of forecasting.
CO82D**.2**	Analyze the strategy involved in project selection and management
CO82D**.3**	Analyse the methodology followed in project life cycle and crashing the project control.
CO82D**.4**	Enumerate the monitoring, controlling cycle and design of Control Systems.
CO82D**.5**	Identify the essentials of an Audit, policies and activation procedures.

Textbooks:

1.Production and Operation Management: K. Ashwathappa and Siddharth Bhat, Himalaya Publishing House,2010 editions.
2. Project Management: Samule J Mantel, Jr, Jack R. Meredith, Scott M. Shafer, Margaret M, Sutton with M.R. Gopalan, Wiley India Pvt. Ltd.
3. Project Management: A Managerial Approach, Jack R. Meredith, Samuel J. Mantel Jr. Wiley India Pvt. Ltd.

Reference books:

1. Principles of Management: T. Ramasamy, Himalaya Publishing House 8. The McGraw-Hill 36-Hour Project Management Course -McGraw-Hill .
2. Successful Project Management: Milton D. Rosenau, Jr., Cregory D. Githens, Wiley India Pvt. Ltd.

E-Books / Web References

1. https://onlinecourses.swayam2.ac.in/cec21_ge06/preview
2. https://archive.nptel.ac.in/courses/124/106/124106157/

Scheme of Examination:

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Continuous Internal Evaluation (CIE):

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Typical Evaluation pattern for regular courses is shown in Table 2.

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Table 2: Distribution of weightage for CIE & SEE of Regular courses

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**50**
	CIE Test-2	**40**	
	CIE Test-3	**40**	
	Assignment/Quiz /AAT	**10**	
SEE	Semester End Examination	**100**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO82D.**1**	3	2										1			
CO82D.**2**	3	2										1			
CO82D.**3**	3	2										1			
CO82D.**4**	3	2										1			
CO82D.**5**	3	2										1			
Average	3	2										1			

Low - 1: Medium - 2: High - 3

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SEMESTER – VIII

Course: INTERNSHIP

Course Code	22MEDI83	CIE Marks	100
Hours/Week (L: T: P)	0 : 0 : 12	SEE Marks	100
No. of Credits	10	Examination Hours	03

Internship:
All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. Internship examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

CIE procedure for Internship:
The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Internship shall be based on the evaluation of Internship report, presentation skill and question and answer session in the ratio **50:25:25**.

Typical Evaluation pattern for regular courses is shown in Table.

Table: Distribution of weightage for CIE of Regular courses

	Component	Marks	Total Marks
CIE	Review	100	**100**
SEE	Review	100	**100**
		Grand Total	**200**

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