Department: Mechanical Engineering

Programme: B. Tech. in Mechanical Engineering

Learning Outcomes based Curriculum

Preamble

In a learning outcome-based teaching pedagogy, the demonstrated achievement of outcomes in terms of knowledge, understanding, skills, attitudes, and the academic standard of the graduates is a key concern. Designing the programme outcomes (POs) for a particular under graduate (UG) programme, based on what a graduate in Mechanical Engineering is expected to know, understand and able to do at the end of the study programme is undoubtedly an important aspect. The expected POs are also crucial reference points in the sense that these assist in formulating graduate attributes, qualification descriptors, programme learning outcomes and course outcomes etc. Proper formulation of the above also helps in curriculum planning and development, and also in the design, delivery and review of academic programmes. The four years B. Tech. programme in Mechanical Engineering has been designed taking into consideration the above factors so that all the attributes of a learning outcome based curriculum is met. Additionally, inputs from statutory bodies such as AICTE, NAAC and NBA, along with inputs from stake holders are also taken in consideration before formulating the curriculum.

1. Introduction

The B. Tech. programme in Mechanical Engineering at Tezpur University was started in 2006. Since its inception, the department has been nurturing the talents of the students through its academic programme and specialized laboratories complying with the recent technological developments. The programme is offered with the following Programme Educational Objectives (PEOs).

1. To impart fundamental knowledge of Mechanical Engineering, enabling students to face practical challenges of solving engineering problems.
2. To train students in various core fields of Mechanical Engineering through exposure to the latest technology.
3. To motivate students for higher studies and research.
4. To orient students towards multi-disciplinary research and other co-curricular activities.
5. To inculcate in students the sense of ethics, professionalism, creativity, leadership, entrepreneurship, and self-confidence.

2. Qualification descriptors for the graduates

Knowledge & Understanding

- Demonstrate a fundamental or coherent understanding of an academic field of mechanical engineering, its different learning areas and applications, and its linkages with related disciplinary areas/subjects;

- Demonstrate procedural knowledge that creates different types of professionals related to mechanical engineering, including research and development, teaching and academics and also the industrial sector.
- Demonstrate comprehensive knowledge about mechanical engineering, including research, relating to essential learning areas pertaining to mechanical engineering. Also develop techniques and skills required for identifying problems and issues relating to the mechanical engineering field of study.

Skills & Techniques

- Demonstrate skills in areas related to mechanical engineering and be up to date on the current developments in the field of mechanical engineering.
- Demonstrate mechanical engineering related skills which are transferable and relevant/required for jobs in industrial sectors and employment opportunities.
- Apply one's knowledge on mechanical engineering and transferable skills to new/unfamiliar contexts, to identify and analyse problems and issues and solve complex problems with well-defined solutions.

Competence

- Meet one's own learning needs, drawing on a range of current research and development work and professional materials;
- Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s)
- Demonstrate competence in identifying information needs, collection of relevant quantitative/qualitative data, analysis and interpretation of data using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments.

3. Graduates Attributes

- Engineering knowledge
- Problem analysis
- Design/development of solutions
- Conduct investigations of complex problems
- Modern tool usage
- The engineer and society
- Environment and sustainability
- Ethics
- Individual and team work
- Communication
- Project management and finance
- Life-long learning

4. **Program Outcomes:** The B. Tech. programme in Mechanical Engineering has twelve programme outcomes. These are given below.

After successful completion of the programme, the graduates will be able to

- Apply knowledge of Mathematics, Science and Engineering in solving problems of Mechanical Engineering.
- Identify, formulate, solve and analyze Mechanical Engineering problems.
- Design machine elements and mechanical systems, conduct experiments, analyze and interpret results.
- Design algorithms or systems to meet desired needs in the context of Mechanical engineering under realistic constraints, such as limited resources, environmental impacts, system performance etc.
- Visualize and work on laboratory.
- Use modern engineering tools, software packages and equipment to solve and analyze problems.
- Understand professional and ethical responsibilities.
- Communicate effectively.
- Understand the impact of engineering solutions on the society, environment and awareness of contemporary issues.
- Develop confidence and ability for self-learning.
- Succeed in various competitive examinations for acquiring better employability.
- Build a strong background for acquiring higher studies and pursuing research in leading organizations.

5. PROGRAMME STRUCTURE

The structure of the B. Tech. Curriculum, which was revised in 2018 as per AICTE guidelines, is attached below (Annexure I (part-I). The number of Core, Elective and Non-credit courses is listed in Annexure I (part-II).

6. SEMESTER-WISE SCHEDULE

The semester wise schedule of courses along with their credit structure is enclosed in Annexure II

7. **Mapping of course with program outcomes (POs)**

The B. Tech. Programme has twelve programme outcomes formulated in line with the graduate attributes of NBA. Each course offered in various semesters also has certain course outcomes (COs). The COs of each and every course is linked with the POs in such a way that the strongest relation has the weight of 3 and the weakest relation is 1. Accordingly, the weight factor of the POs from the respective course is determined. The details are given in a separate sheet as Annexure III.

8. EVALUATION PLAN:

The evaluation plan adopted is a continuous comprehensive evaluation system designed by the university as follows.

1. Sessional Test-I	25
2. Mid-sem examination	40
3. Sessional Test-II	25
4. End-sem Examination	60

As a part of the evaluation plan, question papers are set with levels based on Bloom's taxonomy, with each question linked to the respective course outcomes. Subsequently, the attainment of course outcomes is assessed based on the students' performance in the test (marks attained by the students against questions linked to a particular course outcome).

9. DETAILED SYLLABUS

The detailed syllabus along with their credit structure is enclosed in Annexure IV.

Annexure I (part-I)

B. Tech. Curriculum :: Category-wise distribution of courses

	Category	Course Detail								Category-wise credits
		SN	Code	Title	L	T	P	Cr	CH	
I	Humanities and Social Science including Management courses (HSMC)	1	EF103	English	2	0	1	3	4	12
		2	BA201	Economics	3	0	0	3	3	
		3	IC361	Accounting and Finance Management	3	0	0	3	3	
		4	XXxxx	HSS/Management Elective	3	0	0	3	3	
II	Basic Science Courses (BSC)	1	CH103	Chemistry	3	0	1	4	5	23
		2	MS104	Mathematics I	3	1	0	4	4	
		3	PH103	Physics I	2	0	1	3	4	
		4	PH104	Physics II	2	0	0	2	2	
		5	MS105	Mathematics II	3	1	0	4	4	
		6	MS205	Mathematics III	3	0	0	3	3	
		7	BT201	Biology	3	0	0	3	3	
III	Engineering Science Courses (ESC)	1	EE103	Basic Electrical Engineering	3	0	0	3	3	25
		2	EE104	Basic Electrical Engineering Lab	0	0	1	1	2	
		3	EC102	Basic Electronics	2	1	1	4	5	
		4	ME102	Engineering Mechanics	3	1	0	4	4	
		5	ME103	Workshop Practice	0	0	2	2	4	
		6	CO103	Introductory Computing	3	0	0	3	3	
		7	CO104	Computing Laboratory	0	0	2	2	4	
		8	CE103	Engineering Graphics	1	0	2	3	5	
		9	ME203	Material Science	3	0	0	3	3	
IV	Professional Core Courses (PCC)	1	ME201	Solid Mechanics	3	1	0	4	4	55
		2	ME202	Fluid Mechanics I	2	1	0	3	3	
		3	ME205	Thermodynamics	3	1	0	4	4	
		4	ME208	Manufacturing Technology I	3	0	0	3	3	
		5	ME209	Fluid Mechanics II	2	1	0	3	3	
		6	ME214	Kinematics of Machinery	2	1	0	3	3	
		7	ME215	Mechanical Measurements and Instrumentation	3	0	0	3	3	
		8	ME216	Manufacturing Technology II	3	0	0	3	3	
		9	ME217	ME Lab (Design) I	0	0	2	2	4	
		10	ME308	Heat and Mass Transfer	3	1	0	4	4	
		11	ME311	Machine Design I	2	1	0	3	3	
		12	ME312	Machine Design II	3	0	0	3	3	
		13	ME313	Dynamics of Machinery	3	0	0	3	3	
		14	ME314	Applied Thermodynamics	3	1	0	4	4	
		15	ME315	ME Lab (Manufacturing) II	0	0	2	2	4	
		16	ME316	Computer-Aided Engineering	1	0	2	3	5	
		17	ME317	ME Lab (Thermal) III	0	0	2	2	4	
		18	ME401	Industrial Systems Engineering	3	0	0	3	3	
V	Professional Elective Courses (PEC)	1		ME Elective I	3	0	0	3	3	18
		2		ME Elective II	3	0	0	3	3	
		3		ME Elective III	3	0	0	3	3	
		4		ME Elective IV	3	0	0	3	3	
		5		ME Elective V	3	0	0	3	3	
		6		ME Elective VI	3	0	0	3	3	
VI	Open Elective Courses (OEC)	1		Open Elective I	3	0	0	3	3	12
		2		Open Elective II	3	0	0	3	3	
		3		Open Elective III	3	0	0	3	3	
		4		Open Elective IV	3	0	0	3	3	
VII	Project, Seminar and Internship in Industry or elsewhere (Pr)	1	ME318	Mini Project	0	0	2	2	4	16
		2	ME471	Industrial Summer Training	-	-	-	2	-	
		3	ME483	Project I	0	0	4	4	8	
		4	ME484	Project II	0	0	8	8	16	
VIII	Mandatory-Non-Credit Courses (NCr)	Induction Program ,Environmental Science, , Indian Constitution, and Essence of Indian Traditional Knowledge			-	-	-		13	-
Total					**114**	**12**	**33**	**161**	**205**	**161**

Annexure I (part-II)

Course category		No of courses	Total Credits
I.	Core courses	42	128
II.	Elective courses	11	33
III.	Mandatory-Non-Credit courses	3	0

Annexure-II

Curriculum :: Semester-wise distribution of courses

Sem	Course detail								Total credits in the semester
	SN	Code	Title	L	T	P	Cr	CH	
I	1	CH103	Chemistry	3	0	1	4	5	18
	2	MS104	Mathematics I	3	1	0	4	4	
	3	PH103	Physics I	2	0	1	3	4	
	4	EE103	Basic Electrical Engineering	3	0	0	3	3	
	5	EE104	Basic Electrical Engineering Lab	0	0	1	1	2	
	6	EF103	English	2	0	1	3	4	
	7	SE100	Induction Program	-	-	-	-	8	
II	1	PH104	Physics II	2	0	0	2	2	24
	2	MS105	Mathematics II	3	1	0	4	4	
	3	EC102	Basic Electronics	2	1	1	4	5	
	4	ME102	Engineering Mechanics	3	1	0	4	4	
	5	ME103	Workshop Practice	0	0	2	2	4	
	6	CO103	Introductory Computing	3	0	0	3	3	
	7	CO104	Computing Laboratory	0	0	2	2	4	
	8	CE103	Engineering Graphics	1	0	2	3	5	
III	1	MS205	Mathematics III	3	0	0	3	3	21
	2	BA201	Economics	3	0	0	3	3	
	3	ME201	Solid Mechanics	3	1	0	4	4	
	4	ME202	Fluid Mechanics I	2	1	0	3	3	
	5	ME203	Material Science	3	0	0	3	3	
	6	ME208	Manufacturing Technology I	3	0	0	3	3	
	7	ME217	ME Lab (Design) I	0	0	2	2	4	
	8	ES201*	Environmental Science	1	0	1	0	3	
IV	1	BT201	Biology	3	0	0	3	3	19
	2	ME205	Thermodynamics	3	1	0	4	4	
	3	ME209	Fluid Mechanics II	2	1	0	3	3	
	4	ME214	Kinematics of Machinery	2	1	0	3	3	
	5	ME215	Mechanical Measurements and Instrumentation	3	0	0	3	3	
	6	ME216	Manufacturing Technology II	3	0	0	3	3	
V	1	ME308	Heat and Mass Transfer	3	1	0	4	4	22
	2	ME311	Machine Design I	2	1	0	3	3	
	3	ME313	Dynamics of Machinery	3	0	0	3	3	
	4	ME314	Applied Thermodynamics	3	1	0	4	4	
	5	ME315	ME Lab (Manufacturing) II	0	0	2	2	4	
	6		ME-Elective I	3	0	0	3	3	
	7		Open Elective I	3	0	0	3	3	
	8	LW301*	Indian Constitution	1	0	0	0	1	
VI	1	IC361	Accounting and Finance Management	3	0	0	3	3	22
	2	ME312	Machine Design II	3	0	0	3	3	
	3	ME316	Computer-Aided Engineering	1	0	2	3	5	
	4	ME317	ME Lab (Thermal) III	0	0	2	2	4	
	5	ME318	Mini Project	0	0	2	2	4	
	6		ME-Elective II	3	0	0	3	3	
	7		ME Elective III	3	0	0	3	3	
	8		Open Elective II	3	0	0	3	3	
VII	1	XXxxx	HSS/Management Elective	3	0	0	3	3	21
	2	ME401	Industrial Systems Engineering	3	0	0	3	3	
	3	ME471**	Industrial Summer Training #	-	-	-	2	0	
	4	ME483	Project I	0	0	4	4	8	
	5		ME Elective IV	3	0	0	3	3	
	6		ME Elective V	3	0	0	3	3	
	7		Open Elective III	3	0	0	3	3	
	8	CT465*	Essence of Indian Traditional Knowledge	1	0	0	0	1	
	# Industrial Summer Training: Training shall be of 8 weeks duration carried out during the summer break after the 6th semester. The report will be submitted in the 7th semester.								
VIII	1		ME Elective VI	3	0	0	3	3	14
	2		Open Elective IV	3	0	0	3	3	
	3	ME484	Project II	0	0	8	8	16	
Total				**114**	**12**	**33**	**161**	**205**	**161**

Annexure-III

CO-PO Mapping of the Subjects offered in B.Tech. Mechanical Engg:

Course code	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CH103	CO1	3	x	x	x	3	x	x	x	x	x	3	x
	CO2	3	x	x	x	x	x	x	x	x	x	x	x
	CO3	3	3	x	x	3	x	x	x	x	x	3	3
MS104	CO1	3	x	x	x	x	x	x	x	x	x	x	3
	CO2	3	x	x	x	x	x	x	x	x	x	x	3
	CO3	x	3	x	x	x	x	x	x	x	x	x	3
	CO4	3	x	x	x	x	x	x	x	x	x	x	x
	CO5	x	3	x	x	x	x	x	x	x	x	x	x
PH103	CO1	3	3	x	x	x	x	x	x	x	x	x	x
	CO2	3	3	x	x	x	x	x	x	x	x	x	x
	CO3	x	x	3	x	x	x	x	x	x	x	x	x
	CO4	x	x	3	x	3	x	x	x	x	x	x	x
	CO5	x	3	3	x	3	x	x	x	x	x	x	x
PH104	CO1	3	x	x	x	x	x	x	x	x	x	x	x
	CO2	x	3	x	x	x	x	x	x	x	3	x	x
	CO3	3	x	x	x	x	x	x	x	x	3	x	x
	CO4	x	3	3	x	x	x	x	x	x	x	x	x
	CO5	3	x	x	x	3	x	x	x	x	x	x	x
MS105	CO1	3	x	x	x	x	x	x	x	x	x	3	x
	CO2	3	x	x	x	x	x	x	x	x	x	3	3
	CO3	x	3	x	x	x	x	x	x	x	x	x	x
	CO4	3	x	x	x	x	x	x	x	x	x	x	3
	CO5	x	3	x	x	x	x	x	x	x	x	x	x
ME102	CO1	3	3	3	3	2	2	x	x	3	2	1	2
	CO2	3	3	3	3	2	2	x	x	2	2	1	2
	CO3	2	3	3	2	2	2	x	x	1	2	x	3
	CO4	3	3	3	3	2	2	x	x	2	1	1	3
ME103	CO1	1	x	x	x	2	x	x	x	x	1	x	x
	CO2	1	x	x	x	2	x	x	x	1	1	x	x
	CO3	1	1	x	x	2	x	x	x	1	1	x	x
	CO4	1	1	x	x	2	x	x	x	1	1	x	x
	CO5	1	x	x	x	2	x	x	x	1	1	x	x
MS205	CO1	3	x	x	x	x	x	x	x	x	x	x	x
	CO2	3	x	x	x	x	x	x	x	x	x	x	x
	CO3	3	x	x	x	x	x	x	x	x	x	x	x
	CO4	3	3	x	x	x	x	x	x	x	x	x	x
	CO5	3	3	x	x	x	x	x	x	x	x	x	x
ME201	CO1	x	x	x	x	3	x	x	x	x	x	x	x
	CO2	3	x	x	x	x	x	x	x	x	x	2	3
	CO3	3	x	x	x	x	x	x	x	2	x	x	x
	CO4	x	3	x	x	x	x	x	x	x	x	2	x
	CO5	3	x	x	x	x	x	x	x	x	x	x	2
	CO6	x	3	x	x	x	x	x	x	1	x	x	2
ME202	CO1	2	x	x	x	x	x	x	x	x	2	x	x
	CO2	3	1	x	x	x	x	x	x	x	2	x	x
	CO3	3	1	x	x	x	x	x	x	x	2	x	x

	CO4	3	1	x	x	x	x	x	x	x	2	x	x
	CO5	3	1	x	x	x	x	x	x	x	2	x	x
	CO6	3	2	x	x	x	x	x	x	x	2	x	x
ME203	CO1	3	x	3	3	x	x	x	x	x	x	3	3
	CO2	1	x	1	3	x	x	x	x	3	x	x	3
	CO3	3	x	3	3	x	x	x	x	x	x	2	3
	CO4	3	2	3	3	x	3	x	x	x	x	2	3
	CO5	2	2	2	2	3	3	3	3	x	3	x	3
	CO6	3	x	3	3	x	x	x	x	x	x	3	3
ME208	CO1	2	3	3	3	1	2	2	2	2	x	3	2
	CO2	3	3	2	2	2	x	1	2	2	2	2	2
	CO3	3	3	2	2	3	1	x	1	3	2	2	3
	CO4	2	3	2	2	2	3	2	2	3	3	3	3
	CO5	3	3	3	3	3	2	3	3	3	3	3	3
	CO6	2	3	3	3	1	2	2	2	2	x	3	2
ME217	CO1	3	2	3	x	3	x	2	2	x	3	2	2
	CO2	2	2	2	x	2	x	2	2	x	2	2	2
	CO3	2	2	3	x	3	x	2	2	x	3	2	2
	CO4	3	2	2	x	2	x	2	2	x	2	2	2
ME205	CO1	2	2	x	x	x	x	x	x	x	2	2	x
	CO2	3	1	x	x	x	x	x	x	x	2	2	x
	CO3	3	2	x	x	x	x	x	x	x	2	2	x
	CO4	3	1	x	x	x	x	x	x	x	2	2	x
	CO5	3	2	x	x	x	x	x	x	x	2	2	x
	CO6	3	2	x	x	x	x	x	x	x	2	2	x
ME209	CO1	3	x	2	x	x	x	x	x	x	2	x	x
	CO2	3	1	2	x	x	x	x	x	x	2	x	x
	CO3	3	1	2	x	x	x	x	x	x	2	x	x
	CO4	3	1	2	x	x	x	x	x	x	2	x	x
	CO5	3	1	3	x	x	x	x	x	x	2	x	x
ME214	CO1	3	3	3	3	3	x	x	2	3	3	3	3
	CO2	3	2	x	x	x	x	x	x	x	1	3	3
	CO3	3	2	x	3	x	x	x	x	x	1	x	3
	CO4	3	2	x	x	x	x	x	x	x	1	3	3
	CO5	2	x	x	x	x	x	x	x	x	1	x	3
ME215	CO1	2	x	x	x	1	x	1	x	x	2	2	3
	CO2	3	2	x	x	3	3	2	x	x	2	3	2
	CO3	2	3	x	x	x	x	x	x	x	3	2	2
	CO4	3	3	x	x	3	2	x	1	x	2	3	2
	CO5	3	3	3	3	2	x	x	1	x	2	1	3
ME216	CO1	2	3	3	3	1	2	2	2	2	x	3	2
	CO2	2	3	2	2	2	x	1	2	2	2	3	2
	CO3	3	2	2	2	3	1	x	1	2	2	2	3
	CO4	2	3	2	2	2	3	2	2	1	3	3	2
	CO5	3	3	3	3	3	2	3	3	3	3	3	3
ME308	CO1	1	x	x	x	x	x	x	x	x	1	x	x
	CO2	3	1	x	x	x	x	x	x	x	2	x	x
	CO3	3	1	x	x	x	x	x	x	x	2	x	x
	CO4	3	1	x	x	x	x	x	x	x	2	x	x
	CO5	3	1	x	x	x	x	x	x	x	2	x	x
	CO6	3	2	x	x	2	x	x	x	x	3	x	x

ME311	CO1	2	3	3	3	2	x	x	x	3	2	1	2
	CO2	3	2	3	3	2	x	x	x	2	2	1	2
	CO3	2	3	3	2	2	x	x	x	1	2	x	3
	CO4	3	2	3	3	2	x	x	x	2	1	1	3
ME313	CO1	3	3	1	x	x	x	x	1	x	2	2	3
	CO2	3	3	1	x	x	x	x	1	x	2	2	3
	CO3	3	3	1	x	x	x	x	1	x	2	2	3
	CO4	3	3	1	x	x	x	x	1	x	2	2	3
	CO5	3	3	1	x	x	x	x	1	x	2	2	3
ME314	CO1	3	3	3	x	x	x	x	x	x	1	2	3
	CO2	3	3	3	x	x	x	x	x	x	1	2	3
	CO3	3	3	3	x	x	x	x	x	x	1	2	3
	CO4	3	3	3	x	x	x	x	x	1	1	2	3
ME315	CO1	2	x	x	x	3	x	x	x	x	2	x	x
	CO2	3	x	x	x	3	x	x	x	2	2	x	2
	CO3	2	2	x	x	3	x	x	x	2	2	x	2
	CO4	3	2	x	x	3	x	x	x	2	2	x	x
	CO5	2	x	x	x	3	x	x	x	2	2	x	2
ME504	CO1	3	x	3	3	x	x	x	x	x	x	3	3
	CO2	3	2	3	3	x	3	x	x	x	x	2	3
	CO3	3	2	3	3	x	3	x	x	x	x	2	3
	CO4	2	2	2	2	3	3	3	3	x	3	x	3
ME523	CO1	1	1	1	1	x	x	x	x	x	2	2	2
	CO2	2	1	1	1	x	x	x	x	x	2	2	2
	CO3	3	2	2	3	x	3	2	x	x	2	2	3
	CO4	3	3	2	3	x	3	2	x	x	2	3	3
	CO5	2	2	3	1	x	x	3	x	3	2	2	1
	CO6	3	3	3	2	x	2	x	x	x	2	3	3
ME312	CO1	2	x	2	3	x	x	x	x	x	3	x	x
	CO2	3	1	3	2	x	x	x	x	x	2	x	x
	CO3	2	1	2	2	x	x	x	x	x	2	x	x
	CO4	3	1	3	3	x	x	x	x	x	3	x	x
	CO5	2	1	3	2	x	x	x	x	x	2	x	x
ME316	CO1	1	1	x	x	3	3	x	x	x	3	2	3
	CO2	3	3	2	2	3	3	x	x	x	3	3	3
	CO3	3	3	3	3	3	3	2	x	2	3	2	3
	CO4	x	x	x	x	x	x	x	3	x	2	x	2
ME317	CO1	1	1	3	x	3	2	x	x	x	2	x	x
	CO2	1	1	3	x	3	2	x	x	x	2	x	x
	CO3	1	1	3	x	3	2	x	x	x	2	x	x
	CO4	1	1	3	x	3	2	x	x	x	2	x	x
ME318	CO1	3	3	x	x	x	3	x	x	2	2	x	x
	CO2	x	3	3	3	x	3	x	x	2	2	x	2
	CO3	x	x	x	x	x	x	2	x	x	1	x	x
	CO4	x	x	x	x	x	x	2	3	x	1	x	x
ME434	CO1	1	2	x	1	1	x	2	x	2	x	3	2
	CO2	3	3	x	x	x	x	2	x	2	2	x	2
	CO3	2	3	x	2	2	1	2	x	x	2	2	3
	CO4	3	3	2	x	x	2	2	3	x	3	3	3
	CO5	3	3	3	3	3	3	2	x	2	3	3	3

ME439	CO1	1	2	x	x	x	x	x	x	x	2	2	2
	CO2	3	3	x	x	3	x	x	x	x	2	2	2
	CO3	3	2	x	x	x	x	x	x	x	2	2	2
	CO4	3	1	x	x	x	x	x	x	x	2	2	2
	CO5	3	3	x	x	3	x	x	x	x	2	2	2
	CO6	3	3	x	1	2	x	x	x	x	2	2	2
ME442	CO1	x	x	x	x	2	x	x	x	x	1	1	x
	CO2	1	x	x	3	x	x	x	x	1	1	2	2
	CO3	3	1	x	2	x	x	x	x	x	1	1	2
	CO4	x	x	x	x	2	x	x	x	x	1	2	2
ME401	CO1	2	2	2	1	1	2	2	2	2	x	3	2
	CO2	3	3	3	3	2	2	2	2	2	2	x	2
	CO3	2	3	2	2	3	1	2	1	3	2	2	3
	CO4	3	3	3	3	2	2	2	3	3	3	3	3
	CO5	3	3	3	3	3	3	2	2	3	3	3	3
ME471	CO1	x	2	x	x	2	x	x	x	x	1	x	x
	CO2	2	x	x	2	x	x	x	x	x	2	x	x
	CO3	x	x	x	x	x	x	x	x	x	3	x	x
	CO4	x	3	x	x	x	x	x	x	x	x	x	x
	CO5	x	x	x	x	x	x	x	x	x	x	2	3
ME483	CO1	3	2	3	1	2	1	x	x	1	2	2	2
	CO2	2	3	3	3	2	2	x	x	1	2	2	2
	CO3	3	2	3	2	2	3	x	x	1	2	1	1
	CO4	x	2	x	x	x	x	2	x	x	3	x	x
	CO5	x	x	x	x	x	x	x	3	x	x	x	x
	CO6	3	x	2	2	x	2	3	x	x	x	x	x
ME429	CO1	x	x	x	x	x	x	x	x	x	x	x	x
	CO2	2	2	x	x	x	x	x	x	x	2	2	2
	CO3	3	2	x	x	x	x	x	x	x	2	2	2
	CO4	3	3	x	x	x	x	x	x	x	2	2	2
	CO5	2	1	x	x	x	x	x	x	x	2	2	2
	CO6	2	2	x	x	x	x	x	x	x	2	2	2
ME532	CO1	2	x	1	1	x	x	x	x	x	2	1	1
	CO2	3	2	2	2	x	x	2	x	1	2	3	3
	CO3	3	3	2	2	x	x	x	x	x	2	1	3
	CO4	3	2	1	3	x	2	3	x	3	2	2	2
	CO5	3	3	2	2	x	2	x	x	x	2	3	2
	CO6	3	2	3	3	x	3	2	x	2	2	3	3
ME531	CO1	x	x	x	3	x	2	2	2	x	1	x	x
	CO2	x	x	x	2	x	2	2	2	x	x	x	x
	CO3	x	x	x	2	x	x	2	1	2	1	x	x
	CO4	1	x	x	x	x	x	2	3	x	1	x	x
ME528	CO1	x	x	x	2	x	x	3	x	3	2	x	1
	CO2	1	1	1	x	x	x	x	x	x	2	1	2
	CO3	2	3	3	2	x	2	x	x	2	2	2	3
	CO4	3	3	3	3	x	3	3	x	3	2	3	3
	CO5	3	3	2	2	x	3	2	x	x	2	3	3
ME582	CO1	3	x	3	3	x	x	x	x	x	x	3	3
	CO2	1	x	1	3	x	x	x	x	3	x	x	3
	CO3	3	x	3	3	x	x	x	x	x	x	2	3

	CO4	3	2	3	3	x	3	x	x	x	x	2	3
	CO5	2	2	2	2	3	3	3	3	x	3	x	3
ME601	CO1	1	x	x	x	x	x	x	x	x	1	x	x
	CO2	3	1	x	x	x	x	x	x	x	2	x	x
	CO3	3	1	x	x	x	x	x	x	x	2	x	x
	CO4	3	1	x	x	x	x	x	x	x	2	x	x
	CO5	3	1	x	x	x	x	x	x	x	2	x	x
	CO6	3	2	x	x	x	x	x	x	x	3	x	x
	CO7	2	x	x	x	x	x	x	x	x	2	x	x
	CO8	x	x	x	x	x	x	x	x	x	2	x	x
ME484	CO1	3	2	3	1	2	1	x	x	1	2	2	2
	CO2	2	3	3	3	2	2	x	x	1	2	2	2
	CO3	3	2	3	2	2	3	x	x	1	2	1	1
	CO4	x	2	x	x	x	x	2	x	x	3	x	x
	CO5	x	x	x	x	x	x	x	3	x	x	x	x
	CO6	3	x	2	2	x	2	3	x	x	x	x	x
ME527	CO1	3	x	2	x	x	x	x	x	3	2	x	x
	CO2	2	2	3	x	x	x	x	x	2	3	x	x
	CO3	3	1	2	x	x	x	x	x	2	2	x	x
	CO4	2	2	2	x	x	x	x	x	3	2	x	x
	CO5	3	1	3	x	x	x	x	x	3	3	x	x
	CO6	2	1	3	x	x	x	x	x	2	3	x	x
ME608	CO1	x	x	x	2	x	x	x	x	x	2	x	x
	CO2	x	x	x	x	x	x	x	x	x	2	x	x
	CO3	x	x	x	x	x	x	x	x	x	2	x	x
	CO4	1	x	x	x	x	2	x	x	x	2	x	x
	CO5	1	x	x	x	2	3	x	x	x	2	x	x
	CO6	1	x	x	x	x	x	x	x	x	2	x	x
	CO7	x	x	x	x	2	x	x	x	x	2	x	x
	CO8	x	x	x	x	2	3	x	x	x	2	x	x

Annexure IV
Detailed syllabus

Semester I

CH103	**Chemistry**	**L-T-P-Cr-CH: 3-0-1-4-5**	**Prerequisites: None**

Contents

Unit 1: Atomic and molecular structure: (13lectures)
Schrödinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Unit 2: Spectroscopic techniques and applications: (7lectures)
Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Unit 3: Intermolecular forces and potential energy surfaces: (4lectures)
Ionic, dipolar and van der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

Unit 4: Use of free energy in chemical equilibria: (5lectures)
Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Unit 5: Nuclear Chemistry: (4Lectures)
Isotopes, isotones, isobars, α, β and γ rays, nuclear transformations, fission and fusion, cosmic rays, binding energy, packing fraction, radioactive hazards, nuclear power plants.

Unit 6: Stereochemistry: (4lectures)
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Unit 7: Organic reactions and synthesis of a drug molecule: (5lectures)
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Total: 42 lectures

Practical: -

Experiment 1: Standardization of sodium thiosulphate solution with standard potassium dichromate solution and application for estimation of copper in a solution.
Experiment 2: Determination of the dissociation constant of a weak acid using pH meter.
Experiment 3: Determination of the strength of a strong acid by conductometric titration with a strong base.
Experiment 4: Determination of the strength of a weak acid by conductometric titration with a strong base.
Experiment 5: Determination of the total hardness of water by complexometric titration.

Experiment 6: Preparation of Mohr's salt.
Experiment 7: Determination of the wavelength of maximum absorption (λ_{max} of a colored solution using spectrocolorimeter.
Experiment 8: Preparation of buffer solution and determination of pH

Total: 24 hours

Course Outcomes (COs): -

CO1: Solve problems of chemistry with the knowledge of fundamental principles.
CO2: Connect the basic chemistry knowledge with the daily experiences.
CO3: Utilize the knowledge of chemistry in their future studies.

Reference Books: -

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, byM. J. Sienko andR. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

MS104	Mathematics I	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: None

Contents

Unit 1: Sequence and series: (8 lectures)
Sequence and series of real numbers, tests for convergence. Power series, Taylor's series, series for exponential, trigonometric and logarithm functions.

Unit 2: Calculus: (6 lectures)
Continuity and differentiability of single variable, Rolle's theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders, Indeterminate forms, L'Hospital's rule.

Unit 3: Multivariable calculus: (8 lectures)
Limit, continuity and differentiability of functions of several variables, partial derivatives, directional derivatives, total derivative. Euler's theorem on homogeneous functions. Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Unit 4: Multiple integrals: (10 lectures)
Gradient, Curl, Divergence, Laplacian, line integral, multiple integral, change of order of integration and change of variables, surface integral, theorems of Green. Gauss and Stokes theorems, orthogonal curvilinear coordinates. Simple applications involving cubes, sphere and rectangular parallelepipeds.

Unit 5: Improper integrals: (5 lectures)
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit 6: Ordinary differential equations: (8 lectures)
First order differential equations – exact, linear and Bernoulli's form, second order differential equations with constant coefficients, Euler equations. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

Total: 45 lectures

Course Outcomes (COs): -

CO1: Analyze the concepts of real analysis and its use in Power series, Taylor's series, series for exponential, trigonometric and logarithm functions which will appear in several multidisciplinary problems.
CO2: Evaluate multivariable calculus and its use involving limit, continuity and differentiability of functions of several variables, applied in various engineering problems.
CO3: Identify applications of Green, Gauss and Stokes theorems to evaluate line, surface and volume integrals in an easier way.
CO4: Determine some advance knowledge of integration such as improper integrals which will help the use of Beta-Gamma functions in several engineering problems.
CO5: Recall the theory of Ordinary Differential Equations, which is an inseparable tool for any engineering discipline.

Text Books: -

1. Erwin Kreyszig, Advanced Engineering Mathematics, (John Wiley & Sons, Ninth Edition), 2006.
2. Thomas and Finney, Calculus and Analytic Geometry, (Pearson Education, Eleventh (Indian) Edition), 1998.

Reference Books: -

1. Jain, R. K. and Iyengar, S. R. K. Advanced Engineering Mathematics, (Narosa publishing house, India, Third Edition), 2009.
2. Veerarajan T., Engineering Mathematics for first year, (Tata McGraw-Hill, New Delhi), 2008.
3. Ramana, B. V. Higher Engineering Mathematics, (McGraw Hill, India), 2010.
4. Ross S. L., Differential Equations, (Wiley India, Third edition), 1984.

PH103	Physics-I	L-T-P-Cr-CH: 2-0-1-3-4	Prerequisites: None

Contents

Unit 1: Mechanics: (10lectures)
Curvilinear coordinate systems; Concepts of potential energy, conservative and non- conservative forces; Angular momentum and orbital motion; Non-inertial frames of reference; Rotating coordinate system, Centripetal and Coriolis accelerations

Unit 2: Optics: (9lectures)
Fermat's principle of stationary time and its applications, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection. Young's double slit experiment, Newton's rings, Michelson interferometer, Farunhofer diffraction from a single slit and a circular aperture, Diffraction gratings and their resolving power.

Unit 3: Electromagnetic Theory: (9lectures)
Basics of electrostatics and magnetostatics; Displacement current, Maxwell's equations: Continuity equation for current densities; Maxwell's equation in vacuum; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization.

Total:28 lectures

Practical:-

Experiment 1: Determine the value of surface tension of pure water with the help of capillary action. (Jurine's law).

Experiment 2: Determine the wavelength of He- light by observing the diffraction pattern produced with a plane transmission grating.

Experiment 3: Verify Hooke's law of elasticity and hence determine the value of Young's modulus of elasticity of the material of a given rod by the method of flexure.

Experiment 4: To determine the moment of a bar magnet and horizontal component of earth's magnetic field by Magnetometers.

Experiment 5: Determine the Planck's constant by solar cell.

Experiment 6: Prove the existence of atomic energy levels and determine the first excitation potential (eV) of Argon atom using Frank Hertz Experimental set-up.

Experiment 7: Determine the Planck's constant using different wavelength of light using Planck Constant Kit.

Course Outcomes (COs): -

CO1: Solve numerical problems of mechanics by application of Newton's laws of motion.
CO2: Analyze the application of Newton's laws of motion in non-inertial frames of reference.
CO3: Recall the wave nature of light and interpret the intensity variation of light due to interference and diffraction.
CO4: Describe experimental arrangements for observing interference and diffraction pattern.
CO5: Formulate and solve engineering problems on electromagnetics and electromagnetic plane wave equations.

Reference Books: -

1. Fundamentals of Physics, Halliday and Resnick.
2. Electricity, magnetism and light, W. Saslow.
3. Engineering Mechanics - Dynamics, JL Meriam.
4. An Introduction to Mechanics, D Kleppner & R Kolenkow.
5. Introduction to Electrodynamics, David Griffiths.

EE 103	Basic Electrical Engineering	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: DC Circuits: (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with de excitation. Superposition. Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Unit 2: AC Circuits: (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac cireuits consisting of R, L, C. RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Unit 3: Transformers: (6 hours)

Magnetic materials and magnetic circuits, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Unit 4: Electrical Machines: (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque- speed characteristic and speed control of separately excited de motor. Construction and working of synchronous generators.

Unit 5: Introduction to Semiconductor Devices: (6 hours)

Semiconductor materials. Concept of energy band diagram and doping. Diode, special diodes, clipping and clamping circuits, rectifier circuits using diode, principle and working of BJT, MOSFET, Basic digital electronics concept.

Unit 6: Electrical Installations: (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Total:42 lectures

Course Outcomes (COs): -

CO1: To understand and analyze basic electric and magnetic circuits.
CO2: To study the working principles of electrical machines and semiconductor devices.
CO3: To introduce the components of low voltage electrical installations.

Reference Books: -

1. D. P. Kothari and |. J. Nagrath, "Basic Electrical Engineering". Tata McGraw Hill. 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E.Hughes, "Electrical and Electronics Technology™, Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

EE 104	**Basic Electrical Engineering Laboratory**	**L-T-P-Cr-CH: 0-0-1-1-2**	**Prerequisites: None**

Contents

Experiment 1: Basic safety precautions. Introduction and use of measuring instruments — voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.

Experiment 2: Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).
Sinusoidal steady state response of R-L, and R-C circuits — impedance calculation and verification.
Observation of phase differences between current and voltage. Resonance in R-L-C circuits.

Experiment 3: Transformers: Observation of the no-load current waveform on an oscilloscope (nonsinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.

Experiment 4: Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage, phase-to-neutral voltage, line and phase currents). Phase -shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.

Experiment 5: Demonstration of cut-out sections of machines: de machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.

Experiment 6: Torque Speed Characteristic of separately excited de motor.

Experiment 7: Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor.
Generator operation of an induction machine driven at super-synchronous speed.

Experiment 8: Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.

Experiment 9: Demonstration of characteristic of different diode. Input output characteristic of BJT, MOSFET. Basic structure of clipping clamping circuit.

Course Outcomes (COs): -

CO1: To familiarize with the basic electrical/electronic equipment/component and its working with its operation characteristic.

CO2: To develop an ability to identify, formulate and solve problems related to basic Electrical Engineering.

To develop an ability to design, perform, analyze and interpret experiment/ experimental result on Network/Circuit Theory/ Electrical Machines/BJT/MOSFET.

EF103	**English**	**L-T-P-Cr-CH: 2-0-1-3-4**	**Prerequisites: None**

Pre-requisites (if any)

Basic knowledge of English grammar, rules of writing and speaking in English.

Contents

Theory: -

A: Vocabulary and grammar:

Discussion on the following before and/or after the activities mentioned in B, C and D

Structure of simple sentences; Agreement of verb and subject; Use of adverbials; Tenses, Use of passive in scientific discourse, various types of questions, Direct and indirect narration, Articles, Prepositions**,** English modal verbs, Errors in the use of individual words

B: Reading:

Reading and comprehension: global and local comprehension, drawing inferences

Materials: Stories and essays (preferably a collection of comparatively short essays on scientific, interestingly written topics, short stories- adventure and scientific fiction)
Reading silently in class followed by short comprehension questions, brief writing exercises, summaries in brief, personal responses (not typical question-answer type)- both oral and written. Reading material from Internet and talking and writing about them; reading scientific reports, articles collected from newspapers and magazines, Internet etc. and writing notes etc on them.

C: Writing:

Preparing project proposal and reports, Writing applications of various types and for various purposes Curriculum vitae/ Resume Letters to the editors, letters to various agencies. Essay and Précis, Notice both formal and informal/friendly, Memo/ notes.

D: Speaking: Oral Communicative Activities:

Listening Comprehension: Information transfer activities: Pair and group works involving transfer of information: Gleaning information from different types of written materials including articles etc. and talking about them, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues Communication at Workplace, Interviews, Formal Presentations: Use of Graphic presentation, Presentation aids Formal group discussion, Formal Speech

Course Outcomes (COs): -

The students will: -

CO1: Acquire proficiency in English enabling them to use English for communication and for study purposes.

CO2: Develop their interactive/speaking skills by developing their ability to listen to English for formal, as in class lectures and informal, as in face to face interactive, situations) with a high degree of understanding, and help them to speak English with a reasonable degree of fluency and with an acceptable pronunciation of the sounds of English.

CO3: Develop the basic skill for academic as well as non-academic writing.

Reference Books: -

1. Sharma, S. and B. Mishra (2009). Communication Skills for Engineers and Scientists. PHI, New Delhi.
2. Wood, F. T. (2010) A Remedial English Grammar for Foreign Students. Macmillan, Delhi.
3. Greenbaum, Sidney. (2005). Oxford English Grammar. Oxford University Press, New Delhi, Indian Edition.
4. Kenneth, Anderson, Tony Lynch, and Joan Mac Lean. (2008). Study Speaking. CUP, New Delhi.
5. Lynch, Tony. (2008). Study Listening. CUP, New Delhi.
6. Thomson and Martinet. (2008). A Practical English Grammar. Oxford ELBS, Delhi.
7. Swan, Michael. Practical English Usage. OUP, New Delhi. 1995
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Semester II

PH104	Physics-II	L-T-P-Cr-CH:2-0-0-2-2	Prerequisites: None

Contents

Theory: -

Unit 4: Quantum Mechanics: (11 lectures)
Wave nature of particles and the Schrodinger equation; Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle; Application of Schrodinger equation: particle in a box.

Unit 5: Waves and oscillations: (7 lectures)
Simple harmonic motion, damped and forced simple harmonic oscillator, quality factor, Applications in mechanical and electrical systems, power absorbed by oscillator; superposition of waves and Fourier method, wave groups and group velocity;

Unit 6: Solid state, semiconductor physics and Lasers: (11 lectures) Free electron theory of metals, Fermi level, density of states, Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, LED, photodetector, Solar cells, Laser-device structure, materials, working principle and characteristics.

Total:29 lectures

Course Outcomes (COs)

CO1: Apply the most basic principles of quantum mechanics, waves and solid-state physics and solid-state devices.

CO2: Solve one dimensional quantum mechanical problems and have the ability to see how quantum mechanics is at the heart of solid-state devices.

CO3: Determine why some materials are metals, some are insulators, and some are semiconductors, based on their electronic band structure.

CO4: Analyze problems of carrier generation and transport phenomena in intrinsic and extrinsic semiconductors – which is essential to understand all electronic devices.

CO5: Solve engineering problems dealing with simple, damped or forced harmonic oscillation and perform Fourier analysis of wave phenomenon.

Reference Books: -

1. Introduction to solid state physics- Kittle
2. Quantum mechanics, D. J. Griffiths
3. Oscillations and waves in physics, Ian G. Main
4. The physics of vibrations and waves, H.J. Pain
5. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL
6. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL.

MS105	Mathematics II	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: None

Contents

Unit 1: Linear algebra: (12 lectures)

Rank of a matrix, determinants, Cramer’s Rule. Linear systems of equations, Direct methods: Gauss elimination, Gauss-Jordan elimination and LU factorization.

Vector spaces – Linear dependence of vectors, basis, linear transformations, range and kernel of a linear map, rank and nullity, rank-nullity theorem. Matrix associated with a linear map. Eigenvalues and eigenvectors, Cayley-Hamilton Theorem.

Unit 2: Complex analysis: (6 lectures)

Limit, continuity, differentiability and analyticity of functions Cauchy-Riemann equations, elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

Unit 3: Complex integration: (8 lectures)

Line integrals, contour integral, Cauchy’s integral theorem, Cauchy’s integral formula, Cauchy Integral formula (without proof), Liouville’s theorem and Maximum-Modulus theorem (without proof). Taylor’s series, zeros of analytic functions, singularities, Laurent’s series; Residues, Cauchy Residue theorem (without proof).

Unit 4: Numerical methods-I: (7 lectures)

Finite differences, relation between operators, Interpolation using Newton’s forward and backward difference formulae. Interpolation with unequal intervals: Newton’s divided difference and Lagrange’s formulae. Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson Method, Secant method and Regula-Falsi method.

Unit 5: Numerical methods-II: (6 lectures)

Taylor’s series, Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson’s rules. Numerical solution of ordinary differential equations using Euler and modified Euler’s methods. Runge-Kutta methods.

Unit 6: Integral transform: (6 lectures)

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.

Fourier series, Fourier transforms. methods, inverses and their applications.

Total: 45 lectures

Course Outcomes (COs): -

CO1: Create the required mathematical foundation. He/she will be confident enough to solve various mathematical problems arising in their engineering problems and apply as per their requirement.

CO2: Identify the use of matrix theory to solve the system of linear equations and apply in various engineering problems.

CO3: Recall the concepts of eigenvalues and eigenvectors in future engineering applications.

CO4: Apply the knowledge of complex analysis for analyzing engineering problems and develop solution techniques for complex problems.

CO5: Measure the techniques of integral equations to solve physical and other engineering problems.

Text Books: -

1. Erwin Kreyszig, Advanced Engineering Mathematics, (John Wiley & Sons, 9th Edition), 2006.
2. Thomas and Finney, Calculus and Analytic Geometry, (Pearson Education, Eleventh (Indian) Edition), 1998.

Reference Books: -

1. Jain, R. K. and Iyengar, S. R. K. Advanced Engineering Mathematics, Third Edition, (Narosa publishing house, India), 2009.
2. Veerarajan T., Engineering Mathematics for first year, (Tata McGraw-Hill, New Delhi), 2008.
3. Ramana, B. V. Higher Engineering Mathematics, (McGraw Hill, India), 2010.
4. Brown J. W. and Churchill R. V., Complex Variables and Applications, (Mc-Graw Hill, 7th Edition), 2004.

EC102	Basic Electronics	L-T-P-Cr-CH: 2-1-1-4-5	Prerequisites: None

Contents

Unit 1: Diodes and Applications: (10 hours)
Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications

Unit 2: Transistor Characteristics: (10 hours)
Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET) – Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuits

Unit 3: Transistor Amplifiers and Oscillators: (7 hours)
Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies, Current Series and Voltage Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators;

Unit 4: Operational Amplifiers and Applications: (5 hours)
Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal OpAmp, Concept of Virtual Ground;

Unit 5: Digital Systems: (10 hours)
Number Systems and Codes, r's Complements and (r- 1)'s Complements, Binary Addition and Subtraction, Representation of Negative Number, Floating Point Representation. Logic Gates: Basic and Universal, Boolean Theorems, De' Morgan's theorems, Sum- of-Products form, Algebraic Simplification, Karnaugh Map, Basic Combinational Circuit Concept: Half Adder, Full Adder, Sequential circuit concept : Basic Flip-Flops (RS, D, JK Flip-Flop).

Basic Electronics Laboratory:

Experiment 1: Laboratory Sessions covering, Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Bread Boards and Printed Circuit Boards (PCBs); Identification, Specifications, Testing of Active Devices – Diodes, BJTs, JFETs, MOSFETs, Power Transistors, SCRs and LEDs.

Experiment 2: Study and Operation of Digital Multi Meter, Function / Signal Generator, Regulated Power Supply (RPS), Cathode Ray Oscilloscopes; Amplitude, Phase and Frequency of Sinusoidal Signals using Lissajous Patterns on CRO; (CRO).

Experiment 3: Experimental Verification of PN Junction Diode Characteristics in A) Forward Bias B) Reverse Bias, Zener Diode Characteristics and Zener Diode as Voltage Regulator, Input and Output Characteristics of BJT in Common Emitter (CE) Configuration, Drain and Transfer Characteristics of JFET in Common Source (CS) Configuration.

Experiment 4: Study of Half Wave and Full Wave Rectification, Regulation with Filters, Gain and Bandwidth of BJT Common Emitter (CE) Amplifier, Gain and Bandwidth of JFET Common Source (CS) Amplifier, Gain and Bandwidth of BJT Current Series and Voltage Series Feedback Amplifiers, Oscillation Frequency of BJT based RC Phase Shift, Hartley and Colpitts Oscillators; Module.

Experiment 5: Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Op-Amp Applications – Differentiator and Integrator, Square Wave and Triangular Wave Generation, Applications of 555 Timer – Astable and Monostable Multivibrators.

Experiment 6: Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop ICs; Serial-In-Serial-Out and Serial-In-Parallel-Out Shift operations using 4-bit/8-bit Shift Register ICs; Functionality of Up-Down / Decade Counter ICs.

Course Outcomes (COs): -

Towards the end of the course the student will learn.
CO1: What is a semiconductor?
CO2: Why is it so important and widely used?
CO3: How the different semiconductor devices work? Their applications in building analog circuits.
CO4: Applications in building digital circuits What is Boolean algebra?
CO5: How to build digital circuits with minimum hardware components?

Reference Books: -

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. Santiram Kal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India
3. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education,
4. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH
5. R. T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson
6. R.L. Boylestad and L.Nashelsky : Electronic Devices and Circuit Theory; PHI, 6e, 2001.
7. A.P. Malvino : Electronic Principles; New Delhi, Tata McGraw-Hill, 1993
8. R.A. Gayakward, “OpAmps and Linear Integrated Circuits, New Delhi : PHI, 2002.

ME102	Engineering Mechanics	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: None

Contents

Unit 1: Force systems:
Force, moment of a force about a point and about an axis, couple moment as a free vector, equivalent force systems **(7L + 1T).**

Unit 2: Equilibrium:
Free body diagram, equations of equilibrium; problems in two and three dimensions, **(4L + 1T)**

Unit 3: Structural Mechanics:
Simple truss, method of joints, method of sections, frames and simple machines **(4L + 1T)**

Unit 4: Friction:
Laws of coulomb friction, angle of friction, applications to wedge, belt-pulley, power screw, journal bearing, brakes and clutches **(3L + 1T)**

Unit 5: Distributed Force System:
Centre of mass, centre of gravity, moment of inertia of an area, product of inertia of an area, mass moment of inertia, product of inertia of a mass **(8L+ 2T)**

Unit 6: Energy Methods:
Principle of virtual work, principle of minimum potential energy **(3L + 1T)**

Unit 7: Kinematics and Kinetics of particles:
Particle dynamics in rectangular coordinates and in terms of path variables; Newton's law for rectangular coordinates, Newton's law for path variables, central force motion
(4L + 1T)

Unit 8: Energy and Momentum Methods for Particle:
Conservative force field, principle of work and energy, principle of impulse and momentum, impact. **(3L+ 1T)**

Unit 9: Kinematics and Kinetics of rigid body:
Translation and rotation of rigid body, motion relative to rotating axes, Coriolis acceleration, equations of motion for a rigid body **(3L + 1T)**

Total: 35 lectures +12 tutorials

Course Outcomes (COs): -

Upon the completion of the course, the students will be able to:

CO1: Solve fundamental problems related to forces being applied to a body under static and dynamic conditions.
CO2: Evaluate the kinetic and kinematic parameters of particles in motion.
CO3: Apply the governing principles of properties of areas in determining centroid and moment of inertia of different sections.
CO4: Identify and model various types of loading and support conditions that act on structural systems.
CO5: Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.
CO6: Evaluate the motion of a particle in terms of its position, velocity and acceleration in different frames of reference and to analyze the forces causing the motion of a particle.

Text Books: -

1. Beer, F.P., Johnston, E.R., Mazurek, D.F., Cornwell, P.J., Eisenberg, and E.R., Sanghi, S. Vector Mechanics for Engineers: Statics and Dynamics. Tata McGraw Hill, 9th edition, 2011.
2. Shames, I.H. and Krishna Mohana Rao, G. Engineering Mechanics: Statics and Dynamics. Pearson Education Prentice Hall India, 4th edition, 2011.

Reference Books: -

1. Meriam, J. L., and Kraige, L.G. Engineering mechanics: Statics, Vol. 1. John Wiley & Sons, 7th edition, 2012.
2. Meriam, James L., and Kraige, L.G. Engineering mechanics: Dynamics. Vol. 2. John Wiley & Sons, 7th edition, 2012.
3. Timoshenko, S., Young, D.H. and Rao J.V., Engineering Mechanics. Tata McGraw Hill, New Delhi, 5th edition, 2010.
4. Hibbler, R.C. Engineering Mechanics: Statics and Dynamics. McMillan, 3rd edition, 2012.
5. Kumar, K.L. Engineering Mechanics. Tata McGraw Hill, New Delhi, 4th edition, 2010.

ME103	Workshop Practice	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: Nil

Contents

Unit 1: Machining (7 Practical)

Introducing to various machine tools and demonstration on various machining process. Making jobs as per drawings.

Unit 2: Fitting Practices (6 Practical)

Study of different vices, power hammer. Making jobs as per drawing.

Unit 3: Welding Practice (6 Practical)

Introduction to different welding processes. Practice on Oxy-acetylene gas welding and manual metal arc welding.

Unit 4: Wireman (7 Practical)

Introduction to different electrical hand tools and machine tools and demonstration on basic electrical components and circuits, making jobs (such as House Wiring, Switch Board etc.) as per drawing.

Total: 26 Practical

Course Outcomes (COs): -

CO1: On the successful completion of the course, the student would be able to:
CO2: Perform machining operations using various manufacturing techniques.
CO3: Perform fitting practices using various types of hand tool and fitting techniques.
CO4: Perform Oxy-acetylene gas welding and manual metal arc welding on jobs.
CO5: Select appropriate electrical hand tools and circuits for the required application and making jobs (such as House Wiring, Switch Board etc.) as per specification.

Text Books: -

1. Chapman, W. A. J. Workshop Technology Part 1. CBS Publishers & Distributors, 5th edition, 2001.
2. Chapman, W. A. J. Workshop Technology Part 2. CBS Publishers & Distributors, 4th edition, 2005.

Reference Books: -

1. Thereja, B. L. and Thereja, A. K. A Textbook of Electrical Technology Vol 1. S. Chand, 22rd edition, 1999.
2. Raghuwanshi, B. S. Workshop Technology Vol. 1. Dhanpat Rai and Sons, 2014.
3. Raghuwanshi, B. S. Workshop Technology Vol. II. Dhanpat Rai and Sons, 11th edition, 2013.
4. Amstead, B. H., Ostwald, P. F. and Begeman, M. L. Manufacturing Process. Wiley, 8th Edition, 1987.

CO 103	Introductory Computing	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Abstract: This course focuses on the development of programming and problem-solving skills of the students. The course begins with familiarizing the students about the fundamentals of computer system. It emphasizes how real problems can be analyzed, outlined and finally transformed into a well-organized program.

Unit 1: Computer Fundamentals:

- History, Generations, Classification of Computers;
- Software and hardware
- Organization of a Computer: Input/Output devices, Memory, CPU;
- Levels of computer languages.
- Character and number representations in computer.

Unit 2: Introduction to Programming:

- Concept of Algorithm, Flow Chart, Pseudocode, Illustrative Problem Solving Examples.
- Features of a Programming Language: Character Set, Identifiers, Keywords, Data Types, Variables, Declarations.
- Operators & Expressions: Types of operators, precedence and associativity rules;
- Statements: Assignment, formatted and unformatted Input/Output;
- Flow Control- Conditionals and Branching, Iteration;
- Functions: Defining and accessing function, function prototypes, Recursion, Scope rules;
- Data types: Derived and user defined data types (arrays, string, pointers, structures etc.)

(A programming language like C/C++ shall be used as a basis language. The same language is to be used for the laboratory).

Course Outcomes (COs): -

CO1: Students are able to develop algorithms and write programs related to simple and moderate real problems using a programming language.

CO2: Students attain confidence and capability of problem-solving using computer.

Text Books: -

1. Fundamentals of Computers, Rajaram, V.
2. Programming in C, Balaguruswamy.
3. Programming in C, Gottfreid, McGrawHill

Reference Books: -

1. Let us C, Kanetkar Y.
2. Theory and Problems of Computers and Programming, Schied, F. S.
3. The C Programming Language, Kerningham& Ritchie.

CO 104	Computing Laboratory	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: None

Contents

Experiment 1: Familiarization of a computer and the environment and execution of sample programs
Experiment 2: Expression evaluation
Experiment 3: Conditionals and branching
Experiment 4: Iteration
Experiment 5: Functions
Experiment 6: Recursion
Experiment 7: Arrays
Experiment 8: Structures
Experiment 9: Pointers

Text Books: -

1. Programming in C, Balaguruswamy.
2. Programming in C, Gotfreid, McGrawHill.

Reference Book: -

1. Let us C, Kanetkar Y.
2. Understanding pointers in C, Kanetkar Y.

CE103	Engineering Graphics	L-T-P-Cr-CH: 1-0-2-3-5	Prerequisites: None

Contents

Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; projection of lines – traces, true length; projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; projection on Auxiliary planes; Isometric projection, isometric scale; section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Course Outcomes (COs): -

CO1: Develop knowledge about the standard techniques to represent the shapes and dimensions of an object in a scaled drawing.
CO2: Interpret the shapes and dimensions of the objects from the drawings
CO3: Develop knowledge to communicate visually with similarly trained persons about the shapes and dimensions of objects.

Text Books: -

1. N D Bhatt, Elementary Engineering Drawing, Charotar Book Stall, Anand
2. V Lakshminarayanan, Engineering Graphics, R S VaishWanar, Jain Brithers, New Delhi

Reference Book: -

1. A M Chandra, S Chandra, Engineering Graphics, Narosa
2. P. J. Shah, Engineering Graphics, S. Chand

Semester III

MS205	Mathematics III	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: Basic Probability: (10 lectures)
Probability spaces, conditional probability, Discrete random variables, Independent random variables, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, infinite sequences of Bernoulli trials, Probability distributions: Binomial, Poisson - evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution.

Unit 2: Continuous Probability Distributions: (5 lectures)
Continuous random variables and their properties, distribution functions and densities, normal, exponential, and gamma densities.

Unit 3: Applied Statistics: (11 lectures)
Moments, Skewness, Kurtosis, Chebyshev's Inequality, Correlation and regression, method of least squares. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Unit 4: Curve fitting: (4 lectures)
Curve fitting - fitting of straight lines, second degree parabolas and more general curves. Spline's fitting.

Unit 5: Partial differential equations: (15 lectures)
Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method. Second-order linear equations and their classification. Method of separation of variables.

Total:45 lectures

Course Outcomes (COs):-

CO1: Apply the knowledge of binomial, poisson and normal distribution for engineering application.
CO2: Recall different problems related to moments, skewness, kurtosis and correlation, regression.
CO3: Measure various physical models through discreet and continuous distributions.
CO4: Identify the use of different test of significance to various engineering problems.
CO5: Analyse the techniques of partial differential equations to solve physical and other problems involving functions of several variables.
CO6: Determine heat and sound equations, fluid flow, elasticity, electrostatics, electrodynamics, etc., problems using partial differential equation techniques.

Text Books: -

1. Erwin Kreyszig, Advanced Engineering Mathematics, (John Wiley & Sons, 9th Edition), 2006.
2. Thomas and Finney, Calculus and Analytic Geometry, (Pearson Education, Eleventh (Indian) Edition), 1998.
3. Feller, W. An Introduction to Probability Theory and its Applications, Vol. 1, (Wiley), 1968.

Reference Books: -

1. Jain, R. K. and Iyengar, S. R. K. Advanced Engineering Mathematics, Third Edition, (Narosa publishing house, India), 2009.
2. Veerarajan T., Engineering Mathematics for first year, (Tata McGraw-Hill, New Delhi), 2008.

3. Ramana, B. V. Higher Engineering Mathematics, (McGraw Hill, India), 2010.
4. Hoel P. G., Port S. C. and Stone C. J., Introduction to Probability Theory, (Universal Book Stall, New Delhi), 2003.
5. Ross, S., A First Course in Probability, (Pearson Education, India), 2002.

BA201	Economics	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: Basic Principles and Methodology in Economics.
Demand and Supply analysis; Elasticity measurement. Theory of the Firm and Market Structure-Perfect Competition, Monopoly, Monopolistic Competition, Duopoly, and Oligopoly.
Basic Macroeconomics- National income, (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, inflationary growth and Phillips Curve.
Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy

Unit 2: Public Sector Economics
Welfare, Externalities, Labour Market. Public utilities, public and private expenditure, and public income. Taxation.

Unit 3: Elements of Business/Managerial Economics and forms of organizations.
Cost & Cost Control – Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows).
Business Forecasting – Elementary techniques.

Unit 4: Indian economy
Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity.
Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization.
Employment–Informal, Organized, Unorganized, Public, Private.
Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors.

Unit 5: Introduction to Acts pertaining to-Minimum wages: -
Workman's compensation, Contracts, Arbitration, Easement rights.

Reference Books: -

1. Salvadore, Dominik. (2009). Microeconomics: Theory and Applications. Oxford University Press.
2. D. N. Dwivedi. (2011). Microeconomics. Pearson Education.
3. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
4. V. Mote, S. Paul, G. Gupta (2004), Managerial Economics, Tata McGraw Hill
5. Misra, S.K. and Puri (2009), Indian Economy, Himalaya
6. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration.

ME201	Solid Mechanics	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: ME102

Contents

Unit 1: Simple Stress and Strain:

Introduction, Stress at a point, Types of stress, Strain, Shear and Normal strain. Stress-strain diagram, True stress and True strain, Hooke's law, Poisson's ratio, Material properties for isotropic materials and their relations, Generalized Hooke's law, Stress-strain relationship. Statically indeterminate systems, Stresses induced in compound bars, Thermal stresses and strains. **(6L + 2T).**

Unit 2: Transformations of Stress and Strain:
Components of stress, Stresses on an inclined plane or Transformation of plane stress, Principal stress and Principal planes, Maximum shearing stress and plane of maximum shearing stress, Mohr's circle for plane stress, Stresses in thin- walled sections, Principal strains, Direction of principal strains and maximum shearing strain, Mohr's circle for plane strain. **(6L + 2 T).**

Unit 3: Shear Force and Bending Moment diagrams:
Axial loaded members, beams, relation between load, shear force and bending moment, drawing of shear force and bending moment diagram for different loading condition of beams. **(4L + 2T).**

Unit 4: Torsion:
Introduction, circular shaft under torsion, stepped shaft and shaft of varying sections, shafts in series and parallel. Bending Stress in Beams: Stresses due to bending: pure Bending, transverse shear. **(4L + 2T).**

Unit 5: Bending of Beams:
Pure Bending; Neutral axis; Theory of simple bending (Bending Equation of beam); section modulus; combined stresses due to bending, torsion and axially loading. **(4L + 1T).**

Unit 6: Deflection of Beams:
Introduction, elastic curve, slope and deflection at a point - double integration method, principle of superposition, Macaulay's method, area moment method. **(4L + 2T).**

Unit 7: Energy Methods:
Strain energy; Toughness; Resilience; Strain energy due to axial, torsion, bending and transverse shear; Castigliano's theorem; Reciprocity theorem, Principle of virtual work; Minimum potential energy; statically indeterminate systems. **(4L + 1T).**

Unit 8: Column:
Introduction to buckling, Euler critical (buckling) load for long columns, effective or equivalent length, slenderness ratio. **(3L + 1T).**

Unit 9: Miscellaneous topics:
Unsymmetrical bending, shear centre and shear flow. **(3L + 1T).**

(Total: 38 lectures + 14 tutorials)

Course Outcomes (COs): -

On successful completion of this course students will be able to

CO1: Recognize physical phenomena in the context of Solid Mechanics.
CO2: Demonstrate understanding of the theories of Solid Mechanics for deformable bodies.
CO3: Apply mechanics of deformable bodies to solve engineering problems.
CO4: Demonstrate understanding of the relationships among loads, member forces and deformations with stresses and strains.
CO5: Demonstrate understanding of the assumptions and limitations of the theories of Solid Mechanics
CO6: Competence in problem identification, formulation and solution.

Text Books: -

1. Hearn, E., J., Mechanics of Materials 1. Elsevier, 3rd edition, 2008.
2. Hearn, E., J., Mechanics of Materials 2. Elsevier, 3rd edition, 2008.
3. Popov, E. P. Engineering Mechanics of Solids. Pearson, 2nd edition, 2010.

Reference Books:-

1. Beer, F. P. and Jhonston, E. R. Jr. et al. Mechanics of Materials. Tata McGraw Hill, New Delhi, 5th edition, 2009.
2. Pytel, A. and Singer, F. L. Strength of Materials. Addision Wesley (AWL), 4th edition, 1999.
3. Timoshenko, S. Strength of Materials Vol. I. CBS Publication, New Delhi, 3rd edition, 2004.
4. Timoshenko, S. Strength of Materials Vol. II. CBS Publication, New Delhi, 3rd edition, 2004.
5. Hibbeler, R. C., Mechanics of Materials, Prentice Hall, 8th edition, 2011.
6. Shames, I. H. and Pitarresi, J. M., Introduction to Solid Mechanics, PHI Learning, 3rd edition, 2009.

ME202	Fluid Mechanics I	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME102

Contents

Unit 1: Introduction:
Definition of fluid, concept of fluid continuum, fluid properties (viscosity, surface tension, vapour pressure and compressibility etc.), types of fluid, Newton's Law of viscosity, power law model for non-Newtonian fluid **(2L + 1T).**

Unit 2: Fluid Statics:
Forces on fluid element (body force and surface force), pressure force on a fluid element, units and scales in pressure measurement, pressure measurement by Barometer, pressure/vacuum gauges and manometers, hydrostatic forces on plane and curved surfaces, Buoyancy and stability of submerged and floating bodies **(6L + 3T).**

Unit 3: Fluid kinematics:
Velocity field, description of fluid motion by Lagrangian and Eulerian method, steady and unsteady, uniform and non-uniform flow, laminar and turbulent, material derivative, streamline, path line, streak line, translation, deformation and rotation of fluid element **(4L + 1T).**

Unit 4: Governing equations and its applications:
Conservation of mass, momentum and energy, governing equations in differential and integral form, Reynolds transport theorem, application of momentum theorem for determination of forces on plane and curved surf aces due to impact of liquid jet and on pipe bends due to flow of fluid, Euler's equation and Bernoulli's equation, Application of Bernoulli's equation, measurement of flow through pipes using venturimeter, orificemeter and pitot tube, flow through orifice and mouthpiece **(6L + 2T).**

Unit 5: Physical similarity and dimensional analysis:
Importance, geometric, kinematic and dynamic similarity, dimensional analysis, Buckingham's Pi-theorem with applications, Important dimensionless numbers **(4L + 1T).**

Unit 6: Potential flow theory:
Stream function, vorticity, velocity potential, uniform flow, source flow; sink flow, vortex flow, superposition of elementary flows, Rankine half body, doublet, and flow past a cylinder **(4L + 1T).**

Unit 7: Viscous incompressible flow in duct:
Stokes law and determination of viscosity, Navier stokes equations in Cartesian and polar coordinates; exact solution of Navier stokes equations, parallel flow in straight channels, Couette flow and Hagen Poiseuille flow, major and minor loss, friction factor, turbulent pipe flow, Moody's diagram, pipe network analysis of multiple pipe system, Hardy- Cross method **(6L + 3T).**

Total: (32 lectures+12 tutorials)

Course Outcomes (COs): -

On the successful completion of the course, the student would be able to:

CO1: Have the knowledge of fluid properties for solving related application-oriented problems.
CO2: Calculate the hydrostatic forces on fluid elements and submerged/floating objects.
CO3: Evaluate the kinematic parameters of fluids like velocity, acceleration and rotation.
CO4: Apply the governing equations of fluid flow to find out the forces due to impact of jet on solid surfaces, and solve problems related to pipe flows and flow-measurements.
CO5: Apply the principles of physical similarity and dimensional analysis to engineering problems.
CO6: Identify the conditions under which exact solutions of the incompressible Navier-Stokes equations can be found and solve fully-developed, viscous incompressible flow problems through ducts.

Text Books: -

1. White, F. M. Fluid Mechanics. McGraw-Hill Education, 8th edition, 2015.
2. Chakrabarty, S., Som, S. K. and Biswas, G. Introduction to Fluid mechanics and Fluid Machines. Tata McGraw Hill, 3rd edition, 2012

Reference Books: -

1. Pritchard, P. J. Fox and McDonald's Introduction to Fluid Mechanics. John Wiley and Sons Inc., 8th edition, 2011.

ME203	Material Science	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: Nil

Contents

Unit 1: Classification and Properties of Engineering Materials: (5 lectures)
Bonds in solids and characteristics of metallic bonding, General classifications, properties and applications of alloy steel, stainless steel, cast iron and non-ferrous materials like copper-aluminium- and nickel- based alloys.

Unit 2: (5 lectures)
Introduction to Ceramic, Polymeric and Composites materials

Unit 3: Crystal Systems and Imperfections: (5 lectures)
Crystallography, Miller Indices for directions and planes, Voids in crystals, Packing density, Crystal imperfections: point, line, surface and volume defects

Unit 4: Dislocations: (5 lectures)
Characteristics, Types and generation of dislocations, Deformation mechanisms and strengthening mechanisms in structural materials.

Unit 5: Phase Diagrams and Phase Rules: (5 lectures)
Principles and various types of phase diagrams, Fe- Fe3C diagram, TTT and CCT diagrams, Heat treatment in Steels, Pearlitic, bainitic and martensitic transformations.

Unit 6: Hot working and cold working of metals: (2 lectures)
Recovery, re-crystallization and grain growth

Unit 7: Material testing: (3 lectures)
Tensile (stress-strain diagrams and related terminologies), Hardness, and Impact testing

Unit 8: Failure of metallic materials: (2 lectures)
Creep fatigue and fracture phenomena.

Unit 9: (5 lectures)
Basic Ideas of Materials Selection and Design.

Total: 37 lectures

Course Outcomes (COs): -

On successful completion of this course, students will be able to:

CO1: identify the general and advanced engineering materials, their properties and applications.
CO2: explain the need of advanced and non-conventional materials.
CO3: identify the criteria for selection of materials during design and manufacturing.
CO4: correlate material properties with design considerations.
CO5: present the outcome carried out in the form of group projects on material characterization and different manufacturing aspects.

Text Books: -

1. Callister, W. D. Material Science and Engineering - An Introduction. John Wiley & Sons, 7th edition, 2007.
2. Dieter, G. E. Mechanical Metallurgy. McGraw Hill, 3rd edition, 1988.

Reference Books: -

1. Smith, W. F. Principles of Materials Science. McGraw Hill, 2003.
2. Raghavan, V. Materials Science and Engineering. Prentice Hall, 6th edition, 2015.

ME208	Manufacturing Technology I	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: Nil

Contents

Theory: -

Unit 1: Introduction: (2 lectures)
Introduction to manufacturing processes

Unit 1: Casting processes: (15 lectures)
Types and stages of casting processes, Various foundry casting techniques viz. sand casting, die casting, continuous casting, centrifugal casting and investment casting, Types and properties of molding materials, pattern materials and core materials, Flow properties of molten metal, Gating and rising systems, Use of chills and chaplets; Principles of solidification of molten metal during casting, Directional solidification, Casting defects and their remedies, Quality assurance.

Unit 2: Joining Processes: (10 lectures)
Principles and applications of welding, brazing, soldering and solid-state joining processes, Weldability of different materials and their metallurgical and mechanical aspects, Welding defects and inspection.

Unit 3: Metal Forming / working Processes: (10 lectures)
Principles, analysis and application of various metals forming techniques viz. forging, rolling, extrusion, drawing, sheet metal forming, super plastic deformation, Forming defects and their remedies.

Unit 4: (3 lectures)
Powder metallurgy and its applications.

Total: 40 lectures

Course Outcomes (COs): -

On successful completion of this course, students will be able to:
CO1: gain detailed knowledge on different industrial manufacturing processes, advanced or non-conventional manufacturing systems.
CO2: can correlate different engineering materials and design considerations with their manufacturing techniques.
CO3: prepare for advanced workshop practice.
CO4: initiate project based on metal casting, metal working and metal joining processes.

Text Books: -

1. Campbell, J. S. Principles of Manufacturing Materials and Processes. Tata McGraw Hill, 1st edition, 2004.
2. Kalpakjian, S. and Schmid, S.R. Manufacturing Engineering and Technology. Pearson/Prentice Hall, 7th edition, 2013.

Reference Books: -

1. Ghosh, A. and Mallik, A. K. Manufacturing Science. East West Press, 2nd edition, 2010.
2. Rao, M. J. Manufacturing Technology: Foundry, Forming and Welding. McGraw Hill Higher Ed, 4th edition, 2013.

ME 217	ME Lab (Design) I	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: Nil

Contents

Unit 1: Engineering Mechanics Laboratory: (5 Practical)
Verification of the parallelogram and triangle law of forces; Verification of reaction forces in a simply supported beam; Verification of Hooke's law with the help of a coil spring; Determination of coefficient of friction by the inclined plane apparatus; Evaluation of centroid of different planar objects.

Unit 2: Strength of Material Laboratory: (7 Practical)
Determination of percentage of elongation, yield strength and ultimate strength employing uniaxial tensile and compression test on mild steel bar; Vickers hardness test; Brinell hardness test; Rockwell hardness test; Determination of toughness of steel by impact testing (Izod test and Charpy test).

Unit 3: Theory of Machine Laboratory: (7 Practical)
Study on the influence of inertia upon velocity and acceleration; Study on gyroscopic apparatus; Study of whirling of shafts phenomena; Study on centrifugal governor; Study of static and dynamic balancing of an unbalanced system; Demonstration of various kinematic models and their applications.

Unit 4: Vibration Laboratory: (7 Practical)
Finding location of the centre of percussion of a compound pendulum; Finding the stiffness of a spring and acceleration due to gravity g of a spring- mass system; Undamped vibration absorber; Force and free undamped vibration of a rigid body; Force and free damped vibration of a rigid body.

Total: 26 Practical

Course Outcomes (COs): -

After successful completion of the course, the student will

CO1: Be able to understand the measurement of mechanical properties of materials,
CO2: Have understood the importance of fundamental science and engineering skills that are needed in engineering.
CO3: Be able to characterize the dynamic behavior of mechanical systems,
CO4: Have experienced the many stages in performing, analyzing and reporting of experimental data, comparison of the results with the relevant theories and eventually reporting the results both orally and written in a team environment.

Reference Books: -

1. Kumar, K. L. Engineering Mechanics. Tata McGraw Hill, 4th edition, 2017.

2. Thomson W. T., Dahleh M. D. and Padmanabham C. Theory of Vibrations with Applications. Pearson, 5th edition, 2008.
3. Popov, E. P. Engineering Mechanics of Solids. Pearson, 2nd edition, 2010
4. Ghosh, A. and Mallik A. K. Theory of Mechanisms and Machines. EWP publications, New Delhi, 3rd edition, 2014.

Semester IV

BT 201	**Biology**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: None**

Contents

Unit 1: Biological Structures and Organization:
- Biological macromolecules, cellular organization, cell types, membrane structures and functions.
- Cellular energetics: Structure of Mitochondria, Energy transduction; Structure of Plastids (chloroplast), Photosynthetic light and dark reaction.

Unit 2: Biological systems:
- Muscular skeletal system, Nervous system (overview of the major human sensory organs and their (functioning), Cardiovascular system.

Unit 3: Biological Information:
- DNA: Structure, Genetic code, Central dogma in Molecular Biology.
- Protein synthesis
- Biological data and Bioinformatics.
- Signal transduction in plants and animals
- Basic concepts

Reference Books: -

1. N Hopkins, J W Roberts, J A Steitz and A M Weiner, “Molecular Biology of the Gene”, J Watson, 4th Ed. Benjamin Cummings, Singapor, 1987.
2. J L Tymoczko, L Stryer, “ Biochemistry”, J M Berg, 5th Ed. W H Freeman & Co, New York, 2002.
3. Dr. C CChatterjee, “Human Physiology”, 11th Ed., Vol I & II, Medical Allied Agency, Kolkata, 1987.
4. Guyton, “Human Physiology”.

ME205	**Thermodynamics**	**L-T-P-Cr-CH: 3-1-0-4-4**	**Prerequisites: Nil**

Contents

Unit 1: Introduction and basic concepts:

Basic definitions, thermodynamic systems and control volumes, properties, states, thermodynamic equilibrium, change of state, processes and cycles **(3L + 1T)**

Unit 2: Temperature:

Zeroth law, thermometers and thermocouple, international temperature scale Energy transfer: Work transfer, pdV and other types of work transfer, heat transfer, specific heat at constant pressure and volume, latent heat, comparison of heat and work **(4L + 2T)**

Unit 3: First law of thermodynamics:

First law for a closed system undergoing a cycle and change of state , internal energy, enthalpy, PMM-I, limitations of first law, non-flow and flow processes; steady state, steady flow and transient flow processes; application of first law to steady flow process, steady flow energy equation(SFEE) **(6L+ 4T)**

Unit 4: Second law of thermodynamics:

Kelvin Plank statement, Claussius statement, Irreversibility, Carnot Cycle, Corollaries of Carnot’s theorem, Applications of Second Law to closed and open systems, heat engine, heat pump and

refrigerator, PMM-II, entropy, Claussius theorem, Claussius inequality, T-ds Relations, entropy principle and its application, entropy generation in closed and open system, absolute entropy and third law of thermodynamics **(7L + 5T)**

Unit 5: Availability:
Definition, quality concept of energy, Reversible work and irreversibility, Exergy balance in closed and open system, Second law efficiency, Guoy Stodola theorem **(4L + 3T)**

Unit 6: Properties of pure substance:
Definition, p-v, T-s and h-s diagram of pure substance (water), properties of steam, use of steam tables and charts (Mollier diagram) **(3L + 2T)**

Unit 7: Introduction to IC Engines:
Introduction to Power Cycle: Carnot, Rankine and Modified Rankine Cycle.
(2L + 2T)

Total: (29 lectures + 19 tutorials)

Course Outcomes (COs): -

On the successful completion of the course, the student would be able to:
CO1: Discuss the use of boundaries in open and closed systems.
CO2: Define the meaning of the state of a working substance.
CO3: Understand concepts of heat, work, and energy.
CO4: Explain basic thermodynamic properties and units.
CO5: Develop and apply the continuity equation for open and closed systems.
CO6: Derive and discuss the first law of thermodynamics.
CO7: Explain properties of solids, liquids, and vapors.
CO8: Use thermodynamic diagrams.
CO9: Discuss basic thermodynamic cycles and systems.
CO10: Apply the second law of thermodynamics to thermal cycles.

Text Books: -
1. Cengel, Y. A. and Boles, M. A. Thermodynamics, an Engineering Approach. McGraw-Hill Education, 8th edition, 2014.
2. Nag, P.K. Engineering Thermodynamics. Tata McGraw Hill, 5th edition, 2013.

Reference Books: -
1. Borgnakke, C. Sonntag, R.E. Fundamentals of Thermodynamics. John Wiley and Sons, 8th edition, 2014.
2. Moran,M.J., Shapiro, H.N., Boettner, D.D. and Bailey, M.B., Principles of Engineering Thermodynamics. S.I. version, John Wiley and Sons, 8th edition, 2011.

ME209	Fluid Mechanics II	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME202

Contents

Unit 1: Introduction to Boundary Layer concepts:
Boundary layer flow, Boundary layer equations, the flat plate boundary layer, definition of boundary layer, displacement, momentum and energy thickness, Blasius similarity solution, Von Karman momentum integral equation, separation of boundary layer. Flow past immersed bodies. (4L + 2T)

Unit 2: Turbulent flow:
Laminar turbulent transition, derivation of Governing equations for turbulent flow, turbulent boundary layer equation, Prandtl's mixing length hypothesis, Universal velocity distribution law, and friction factor correlation (4L + 2T)

Unit 3: Compressible flow:

Introduction, Speed of sound; adiabatic and isentropic steady flow, Mach-number relations, isentropic flow with area changes, Normal-shock wave, Rankine-Hugoniot relations, performance of nozzles, Fanno and Rayleigh flow (9L + 4T)

Unit 4: Turbo machinery:
Euler-equation for turbo-machines, impulse turbine and reaction turbine, Pelton wheel, Francis turbine, Kaplan/propeller turbine, water hammer and surge tank, Rotodynamic and positive displacement pumps, working principle of reciprocating pump, air vessel, Centrifugal pump, its components and working principle, performance characteristics of centrifugal pump vis-à-vis system characteristics, dimensionless terms, specific speed, Cavitation and net positive suction head. (10L + 5T)

(Total: 27 lectures + 13 tutorials)

Course Outcomes (COs): -

On the successful completion of the course, the student would be able to:

CO1: Solve laminar and turbulent pipe-flow problems.
CO2: Analyze and solve laminar and turbulent boundary-layer problems.
CO3: Solve compressible-flow problems involving isentropic flows, flows with normal shocks, flow through a converging-diverging nozzle with shocks, compressible-flow problems involving friction and heat transfer
CO4: Carry out performance analysis of Pelton, Francis and Kaplan turbines, reciprocating and centrifugal pumps.
CO5: Extend the knowledge of dimensional analysis and similitude to the analysis of turbo machines.

Text Books: -

1. White, F. M. Fluid Mechanics. McGraw-Hill Education, 8th edition, 2015.
2. Anderson Jr., J. D. Modern Compressible Flow with Historical Perspective. McGraw-Hill Education (India) Pvt. Ltd., 3rd edition, 2017.

Reference Book: -

1. Chakrabarty, S., Som, S. K. and Biswas G. Introduction to Fluid mechanics and Fluid Machines. Tata McGraw Hill, 3rd edition, 2012.
2. Zucker, R. D. and Biblarz, O. Fundamentals of Gas Dynamics. John Wiley and Sons, 2nd edition, 2002.

ME214	Kinematics of Machinery	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME102

Contents

Unit 1: Introduction:
Basic kinematic concepts; Kinematic pairs; Plane and space mechanisms; Kinematic chains; Kinematic diagrams, Limit and disguise of revolute pairs; Kinematic inversion; Equivalent linkages; Mobility and range of movement. (**8L + 3T**)

Unit 2: Kinematic analysis of plane mechanisms:
Displacement analysis; Instantaneous centre of velocity; Aronhold-Kennedy theorem of three centres; Velocity and acceleration analysis (graphical and analytical);
Velocity and acceleration images. (**6L + 3T)**

Unit 3: Dimensional synthesis of linkages:

Two and three position synthesis - graphical method, Freudenstein's equations; Importance of Chebyshev accuracy points in approximate synthesis. (**3L + 2T**)

Unit 4: Cams:
Classification of followers and cams; Radial cam nomenclature; Description of follower movement; Analysis of follower motion; Determination of basic dimensions of cams. (**5L + 3T)**

Unit 5: Gears:
Gearing action; Fundamental law of gearing; Properties and characteristics of involute action; Introduction to helical, Spiral, Bevel, and Worm gears; Gear trains. (**4L + 2T**)

(Total: 26 Lectures + 13 Tutorials)

Course Outcomes (COs): -

On the successful completion of the course, the student:

CO1: would be able to appreciate and apply the framework acquired during this course to analyze and synthesize the mechanisms and machines for real-life problems/situations.
CO2: would be able to evaluate kinematic parameters related to motion of planar mechanisms using graphical and analytical methods.
CO3: would be able to use the principle of kinematic inversion to solve synthesis problems related to motion generation, path generation, and function generation.
CO4: would be able to understand and analyze the use of cams and gears for generating complex coordinated movements.
CO5: would get motivated to take up advanced courses like robotics etc.

Text Books: -

1. Uicker, J. J., Pennock G. R. and Shigley J. E. Theory of Machines and Mechanisms. Oxford University Press, New Delhi, 5th edition, 2017.
2. Ghosh, A. and Mallik A. K. Theory of Mechanisms and Machines. EWP publications, New Delhi, 3rd edition, 2014.

Reference Book: -

1. Rattan, S. S. Theory of Machines. MacGraw Hill Education (India) Private Limited, New Delhi, 4th edition, 2014.
2. Rao, J. S. and Dukkipati R. V. Mechanism and Machine Theory. New Age International Publishers, New Delhi, 2006.
3. Bevan, T. The Theory of Machines. Pearson, New Delhi, 3rd edition, 2014.
4. Wilson C. E. and Sadler J. P. Kinematics and dynamics of Machinery. Pearson, 3rd edition, 2013.
5. Waldron K. J., Kinzel G. L. and Agrawal S.K. Kinematics, Dynamics and Design of Machinery. Wiley, 3rd edition, 2016.

ME215	Mechanical Measurements and Instrumentation	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: Nil

Contents

Unit 1: Introduction to Metrology: (3 lectures)
General concepts, Definition of different metrological terms, metrology and methods of measurement, Classification of standards, Accuracy of Measurements Precision, Accuracy, Sensitivity, Calibration, Readability, Repeatability, Magnification; Errors in measurements, Limits, Fits and Tolerances, Interchangeability.

Unit 2: Mechanical measurements: (6 lectures)
Linear measurements, Angular and Taper measurements, Screw thread measurements, Gear measurements, circularity measurements, surface finish, straightness and flatness measurements.

Unit 3: Assessing Experimental Data: (4 lectures)
Static performance characteristics: Errors in measurements: Types and sources of errors, methods of elimination or reduction of error, sensitivity, linearity, resolution etc of instruments. Uncertainty analysis.

Unit 4: Statistical analysis of Experimental Data: (6 lectures)
Gaussian distribution of error, least square method of fitting data, linear regression method.

Unit 5: Dynamic Performance Characteristics: (3 lectures)
Zero, first and second order instruments, Signal conditioners: bridge circuit, amplifiers, filters etc.

Unit 6: Sensors and Transducers: (8 lectures)
Definition, classification and detail description of important transducers.

Unit 7: Measurements: (12 lectures)
Basics of measuring instruments, description of instruments used for Displacement Measurements, Pressure measurements, Force measurements, Acceleration, Torque measurements, Flow measurements, Temperature measurements, Strain measurements.

Total: 42 lectures

Course Outcomes (COs): -

On the successful completion of the course, the student would be able to:
CO1: Learn the basics of the science of metrology.
CO2: Identify problems associated to measuring devices and measurements.
CO3: Apply their acquired knowledge to solve problems related to measurements and instrumentation.
CO4: Apply their learning and understanding in the design and working of measuring instruments according to need.

Text Books: -

1. Jain, R.K. Engineering Metrology. Khanna Publishers, New Delhi, 21st edition, 2009.
2. `Nakra, B.C. and Chaudhry, K.K. Instrumentation Measurement and Analysis. Tata McGraw Hill, New Delhi, 4th edition, 2016.

Reference Books: -

1. Beckwith, T.G. Marangoni, R.D. and Lienhard, J.H. Mechanical Measurements. Pearson Prentice Hall, 6th edition, 2007.
2. Holman, J.P. Experimental Methods for Engineers. Mc-Graw Hill, 8th edition, 2012.
3. Rajput, R.K. Mechanical Measurements and Instrumentation. S. K. Kataria and Sons, New Delhi, 2012.

ME216	Manufacturing Technology II	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: ME208

Contents

Unit 1: Metal Cutting: (10 lectures)
Classification of metal removal processes, Mechanics, Chip formation, Surface finish and Machinability, Heat generation and cutting temperature, Cutting fluids.

Unit 2: Cutting Tools: (8 lectures)
Tool geometry, Tool materials and properties, Tool wear and tool life, Tooling: jigs and fixtures.

Unit 3: Setting and Operations on machine tools: (10 lectures)
Lathe, Milling, Shaping, Slotting, Planning, Drilling, Boring, Broaching, Reaming, Grinding, Thread rolling and Gear cutting machines, Gear hobbing, Super finishing processes.

Unit 4: (2 lectures)
Batch production.

Unit 5: CNC Machines: (4 lectures)
NC, CNC, DNC and FMS.

Unit 6: Unconventional Machining: (4 lectures)
Electro-chemical, Electro-Discharge, Ultrasonic, LASER, Electron Beam, Water Jet, Abrasive Jet.

Unit 7: (2 lectures)

Rapid prototyping and rapid tooling.

Total: 40 lectures

Course Outcomes (COs): -

Upon the completion of the course, the students will be able to:

CO1: Identify the different aspects of machining science and machine tools.
CO2: Explain the increased need of advanced, automated and non-conventional machining processes.
CO3: Analyze the cutting tool geometry and design a single point cutting tool for shaping operation.
CO4: Demonstrate a practical understanding of machining operations and fabrication techniques, and to be able to make realistic suggestions for the evaluation of metal cutting behaviour.

CO5: Understand the underlying principles of non-conventional machining and make sound prediction on the selection of specific techniques based on metal cutting behaviour.
CO6: Identify the conditions under which exact solutions for jigs and fixture designs for effective work holding in different machining conditions.

Text Books: -

1. Kalpakjian, S. and Schmid, S.R. Manufacturing Engineering and Technology. Pearson/Prentice Hall, 7th edition, 2013.
2. Ghosh, A. and Mallik, A. K. Manufacturing Science. East West Press, 2nd edition, 2010.

Reference Books: -

1. Hazra Choudhury, S.K., Hazra Choudhury, A.K. and Roy, N. Elements of Workshop Technology Vol II. Media Promoters and Publishers Pvt. Ltd., Mumbai, 2017.
2. Lal, G.K. Introduction to machining science. New Age International Publishers, New Delhi, 3rd edition, 2015.

Semester V

ME308	Heat and Mass Transfer	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: ME205

Contents

Unit 1:
Modes of heat transfer, Conduction; Convection; Radiation, steady and unsteady heat transfer (1L).

Unit 2:
Fourier law of heat conduction, general heat conduction equation, 1-D and 2-D steady state conduction, conduction though plane and composite wall, critical thickness of insulation, conduction with heat generation, 1-D unsteady conduction-Lumped capacitance and analytical methods (7L + 3T)

Unit 3:
Fins, generalized equation for fins, fin performance and design considerations, heat flow through various types of fins (e.g. circular, rectangular and triangular fins) (5L + 2T)

Unit 4:
Fundamentals, free and forced convection; external and internal flows; laminar and turbulent flow; Forced convection through pipe and over cylinder, order of magnitude analysis of momentum and energy equations; hydrodynamic and thermal boundary layers; dimensional analysis, Nusselt number; Prandtl number, Stanton number, Reynolds-Colburn analogy, Free convection from a vertical, horizontal and inclined plate, Free convection from vertical and horizontal cylinders; heat transfer with phase change (boiling and condensation) (10L + 3T)

Unit 5:
Stefan-Boltzmann law; Planck's law; emissivity and absorptivity; radiation heat exchange between black and gray surfaces, Electric network approach for radiation heat exchange, view factor (6L+ 2T)

Unit 6:
Parallel and counter flow heat exchangers, LMTD and effectiveness-NTU methods of heat exchanger design; correction factor for multipass arrangement, heat transfer enhancement techniques (5L+ 2T)

Unit 7:
Molecular diffusion; Fick's law; analogy between heat and mass transfer; evaluation of mass transfer coefficients by dimensional analysis (3L + 1T)

(Total: 37 lectures + 13 tutorials)

Course Outcomes (COs): -

On the successful completion of the course, the student will:

- CO1: know the mechanisms of conduction, convection and radiation heat transfer with relevant laws and governing differential equations in one and multidimensional forms.
- CO2: be able to solve steady and transient conduction problems involving simple to complex geometries both analytically and numerically.
- CO3: be able to learn and analyze the free and forced convection along with boiling and condensation in the practical applications.
- CO4: handle heat exchanger problems using NTU and LMTD methods.
- CO5: have the knowledge of radiation heat transfer such as shape factor, electrical approach and radiation shield will help the learner in performing solar energy related design and modeling.
- CO6: will get a foundation platform to carry out much heat and mass transfer related experimental and computational based projects as well as research works in future.

Text Books: -

1. Incropera, F.P., Bergman, T.L., Dewitt, D.P. and Lavine, A.S. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, 7th edition, 2012.
2. Holman, J.P. Heat Transfer. McGraw Higher Edition, 10th edition, 2011.

Reference Books: -

1. Ozisik, M.N. Heat Transfer-A Basic Approach. McGraw-Hill International Editions, 1985.
2. Bejan, A. Convective Heat Transfer. John Wiley and Sons, 4th edition, 2013.
3. Kreith, F., Bohn, M. and Manglik, R. Principles of Heat Transfer. Cengage Learning, 7th edition, 2011.
4. Cengel, Y.A., Ghajar, A.J. and Kanoglu, M. Heat and Mass transfer. McGraw Hill Education, 4th edition, 2011.

ME311	Machine Design I	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME201

Contents

Unit 1: Introduction to mechanical engineering design:
Overview of machine design, Need of design, Design procedure, Stress-strain, Strength, Rigidity, Engineering materials, Material considerations in design. (**3L**)

Unit 2: Design against static load:
Mode of failure, Factor of safety, Theories of failure: Maximum normal-stress theory, Maximum shear-stress theory and distortion-energy theory. (**4L + 2T**)

Unit 3: Design against fluctuating load:
Fluctuating stresses, Fatigue failure, Endurance limit, Stress concentration, Notch sensitivity, Soderberg, Goodman and Gerber diagrams, Fatigue design under combined stresses. (**4L + 2T**)

Unit 4: Design of shafts, keys and couplings:
Shaft design for stresses (axial, bending and torsional) and combined loading, Shaft materials; Introduction to axle; Types of keys, Introduction to design of keys; Design of rigid and flexible couplings. (**4L + 3T**)

Unit 5: Joints:
Permanent and detachable joints, Introduction to design of welded, bolted and riveted joint; Design of cotter and knuckle joints. (**4L + 2T**)

Unit 6: Belt and chain drives:
Flat and V-belts, Belt slip and creep, Stresses in the belts, Belt materials, Chain drives. (**3L + 2T**)

Unit 7: Mechanical springs:
Helical springs, Leaf springs, Spring materials, Design against static and fluctuating load. (**2L + 2T**)

Unit 8: Manufacturing considerations:
Standardization, Limits, Fits and Tolerance. (**2L**)

(Total: 26 Lectures + 13 Tutorials)

Course Outcomes (COs): -

On successful completion of the course, students will be able to

CO1: Analyze the forces and stresses acting on various machine components, in particular shafts, shaft couplings, keys, belts, chains, and springs; as well as in welded, bolted and riveted joints.
CO2: Analyze and design of structural joints.
CO3: Design such machine components and joints subject to various related design considerations, such as safety factor, service factor, stress concentration, and both static and dynamic failure criteria.
CO4: Understand, identify and quantify failure modes of mechanical parts.

CO5: Incorporate various manufacturing issues in design, such as limits, fits, and tolerance.

Text Books: -

1. Bhandari, V. B. Design of Machine Elements. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 3rd edition, 2014.
2. Gope, P. C. Machine Design: Fundamentals and Applications. PHI Learning Pvt. Ltd., New Delhi, 2012.

Reference Books: -

1. Bhandari V. B. Machine Design: Data book. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 2014
2. Sharma P. C. and Aggarwal, D. K. A Textbook of Machine Design. S. K. Kataria and Sons, New Delhi, 13th edition, 2017.
3. Spotts, M.F., Shoup, T.E., Hornberger, L.E., Jayram, S.R., and Venkatesh, C.V. Design of Machine Elements, Pearson Education. New Delhi, 8th edition, 2006.
4. Norton, R. L. Machine Design – An Integrated Approach. Pearson, 2nd edition, 2012.
5. Shigley, J.E., Mischke, C.R., Budynas, R.G., and Nisbett, K.J. Mechanical Engineering Design. Tata McGraw-Hill, New Delhi, 2008.

ME313	Dynamics of Machinery	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: ME214

Contents

Unit 1: Dynamic force and motion analysis of plane mechanisms:
Motion of a rigid body subjected to a system of forces, D'Alembert principle and dynamic equilibrium; Dynamically equivalent link. (**5L)**

Unit 2: Dynamic analysis of plane mechanisms:
Force- moment analysis of four bar mechanisms; Dynamics of slider-crank mechanism; Derivation of turning moment and turning moment diagram; Fluctuations in crankshaft speed and flywheel. (**7L**)

Unit 3: Governor:
Types of governors; Characteristics and types of centrifugal governors; Hunting of centrifugal governors, control force diagrams of gravity and spring-controlled governors. (**4L**)

Unit 4: Balancing of inertia forces and moments in machines:
Balancing of rotating masses - internal and external balancing, Static and dynamic balancing; multi-plane balancing; Determination of balancing masses; Balancing of rotors - field balancing; Balancing of internal-combustion engines (single cylinder, multi-cylinder, V-engines, direct and reverse crank method). (**8L**)

Unit 5: Vibrations in mechanical systems:
Basic features of vibratory systems; Single-degree- of-freedom systems - free and forced vibrations, Viscous and coulomb damping, Harmonic excitation; Transmissibility and vibration isolation; Two and multi-degree of freedom systems, normal modes, matrix method; orthogonally principle, modal analysis method, Continuous systems (longitudinal, torsional and transverse vibration of beam with different boundary conditions). (**11L**)

Unit 6: Gyroscopic actions in machines:
Principle of gyroscopes; Gyroscopic forces and couple; Gyroscopic stabilization, Application of gyroscope to simple rotating machines, airplane, ship, automobiles etc. (**4L**)

(Total: 39 Lectures)

Course Outcomes (COs): -

After going through this course, the students will be able to:

CO1: Develop a logical framework to analyze a dynamical system, and apply the D'Alembert principle to derive the dynamic equations for various machine components,

CO2: Explain the working of important machine elements like flywheels, governors,
CO3: Understand and Apply balancing technique for static and dynamic balancing of engines and other machine components,
CO4: Understand longitudinal, transverse and torsional vibrations so as to avoid resonance. Compute the damped and undamped natural frequencies, the logarithmic decrement, the time constant and the damping factor and determine whether the system is stable or not,
CO5: Analyze the effect of a gyroscope on ships, aeroplanes and automobile.

Text Books: -

1. Uicker, J. J., Pennock G. R. and Shigley J. E. Theory of Machines and Mechanisms. Oxford University Press, New Delhi, 5th edition, 2017.
2. Ghosh, A. and Mallik A. K. Theory of Mechanisms and Machines. EWP publications, New Delhi, 3rd edition, 2014.
3. Thomson W. T., Dahleh M. D. and Padmanabham C. Theory of Vibrations with Applications. Pearson, 5th edition, 2008.

Reference Books: -

1. Rattan, S. S. Theory of Machines. MacGraw Hill Education (India) Private Limited, New Delhi, 4th edition, 2014.
2. Rao, J. S. and Dukkipati R. V. Mechanism and Machine Theory. New Age International Publishers, New Delhi, 2006.
3. Bevan, T. The Theory of Machines. Pearson, New Delhi, 3rd edition, 2014.

ME314	Applied Thermodynamics	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: ME205

Contents

Unit 1: Brief review on basic knowledge of thermodynamics (1L)

Unit 2: Vapor Power cycles:
Rankine cycle and its representation in various co-ordinate systems, deviations of actual cycle from ideal cycle, Rankine cycle performance, and modifications of ideal Rankine cycle. Low Temperature Power Cycles, ideal working fluid and binary / multi-fluid cycles, cogeneration, **(5L+ 2T)**

Unit 3: Steam Generator (Boiler):
Different types of boilers, Mountings and Accessories. **(2L + 1T)**

Unit 4: Condenser:
Types of Condensers and their working principle. **(1L)**

Unit 5: Steam turbine:
Impulse and reaction turbine, compounding of steam turbine, velocity triangle, efficiencies, degree of Reaction, reheat factor, governing of steam turbine. Steam Nozzles. **(6L + 2T)**

Unit 6: Psychrometry:
Properties of moist air: psychrometry and psychrometric charts and processes, cooling towers. **(2L + 1T)**

Unit 7: Refrigeration:
Vapor compression refrigeration cycle - in T-s and P-h plots, multi-pressure system, and Desirable properties of refrigerants. **(2L + 1T)**

Unit 8: IC engines:
SI and CI engines, two- and four- stroke engines, Engine components, and their working, engine design and operating parameters and its effect on engine performance mean effective pressure, efficiency and specific fuel consumption. Air standard cycles and Air fuel engine cycles, analysis of actual cycle and various losses. Pressure-crank angle diagram, Carburetor and fuel injection systems **(7L + 2T)**

Unit 9: Gas power cycle and gas turbines:
Basic components of Gas Turbine plant, Brayton cycle, deviations of actual cycle from ideal cycle, Reheat, intercooling, regeneration cycles. Combined gas and steam cycles, low temperature power cycles. **(5L + 2T)**

Unit 10: Introduction to jet propulsion:
Turbojet, turbofan, turboprop engines **(1L)**

Unit 11: Reciprocating air compressors:
Components and working principle, Process representation in p-V plane, calculation of work done, and multistage compression with intercooling. **(4L + 1T)**

Unit 12: Introduction to Centrifugal and Axial-Flow Compressors: (3L+ 1T)

(Total: 39 lectures + 13 tutorials)

Course Outcomes (COs): -
Towards the end of the course the student would be able to:

CO1: Analyze the basic, reheat and bled steam power cycles in order to carry out calculations on system performance.
CO2: Construct steam turbine velocity diagrams in order to determine stage calculations mathematically
CO3: Use steam tables and h-s charts to carry out calculations on steam power plant system performance.
CO4: Explain the working of different boilers, condensers and other components of a steam turbine power plant.
CO5: Analyze various gas turbine power plant system arrangements in order to perform heat, work, efficiency, air-fuel ratio, etc. calculation
CO6: Determine thrust developed, efficiencies and fuel consumption of jet engines
CO7: Analyze single and multi-stage reciprocating air compressor cycles in order to carry out calculations on machine performance.
CO8: Construct velocity diagrams for various blade designs of a centrifugal compressor to determine work input, blade efficiency etc.
CO9: Evaluate the performance of Otto, Diesel and Dual cycle IC engines.
CO10: Explain combustion phenomena, injection and ignition systems of IC engines.
CO11: Draw and analyze valve timing diagrams of four stroke IC engines.
CO12: Solve numericals related to this course in various competitive examinations like GATE, UPSC, PSU's etc.
CO13: Study related advanced application-oriented courses such as Gas Turbine and Compressor, Heat Exchanger Design, Refrigeration and Air-conditioning, Compressible Flow, Energy Conservation and Waste Heat Recovery, Advanced Thermodynamics etc.

CO14: Suggest/ implement/ innovate methods of improving efficiency of a thermal power plant along with combined generation/ co-generation.

Text Books: -

1. Cengel, Y.A. and Boles, M.A. Thermodynamics, An Engineering Approach. McGraw Hill Education, 8th edition, 2014.
2. Nag, P.K. Basic and applied thermodynamics. Tata McGraw Hill, New Delhi, 2nd edition, 2010.
3. Nag, P.K. Power plant Engineering. McGraw Hill Education (India), 4th edition, 2014.

Reference Books: -

1. Borgnakke, C. and Sonntag R.E. Fundamentals of Thermodynamics. John Wiley and Sons, 8th edition, 2013.
2. Moran, M.J., Shapiro, H.N., Boettner, D.D. and Bailey, M.B., Principles of Engineering Thermodynamics. S.I. version, John Wiley and Sons, 7th edition, 2014.
3. Rogers, G. F. C and Mayhew, Y. R. Engineering Thermodynamics Work and Heat Transfer. Pearson Education, 4th edition, 1992.
4. Eastop, T. D. and McConkey, A. Applied Thermodynamics for Engineering Technologists. Longman, 5th edition, 1993.

ME315	ME Lab (Manufacturing) II	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: ME203, ME216

Contents

Unit 1: Manufacturing:

Measurement of tool angles and radius of single point cutting tool, Determination of cutting forces and surface roughness with variation of cutting parameters, shear plane, and chip thickness ratio.

(5P)

Unit 2: Machine Tools and Machining:

Selection of Cutting tools – single point cutting tool, carbide tipped tools. Tool signature Selection of cutting speeds and feeds for various machining operations.
Machining operations on lathe, shaping, slotting, milling and grinding machines.

(7P)

Unit 3: Welding Process:

Gas Welding (Oxy acetylene Welding)
Shielded metal arc welding – selection of welding parameters, electrodes. Soldering, Brazing

(6P)

Unit 4: Manufacturing Automation:

NC, CNC, CAM, FMS -3 NC part programming -2
Simulation and manufacturing-2

(8P)

Total: 26 Practical

Course Outcomes (COs): -

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

CO1: Perform machining using various manufacturing techniques.
CO2: Evaluate the accuracy and tolerance of components production
CO3: Perform metal arc welding operations on jobs.
CO4: Understand the advanced manufacturing techniques such as NC and CNC and write their part programming.

Reference Books: -

1. Hazra Choudhury, S.K. Hazra Choudhury A.K. and Roy N. Elements of Workshop Technology Vol II. Media Promoters and Publishers Pvt. Ltd., Mumbai, 2017.
2. Ghosh, A. and Mallik, A. K. Manufacturing Science. East West Press, 2nd edition, 2010.
3. Boothroyd, G and Knight, W.A. Fundamentals of Metal machining and Machine Tools. CRC press, Boca Raton, 3rd edition, 2005.
4. Kalpakjian, S. and Schmid, S.R. Manufacturing Engineering and Technology. Pearson/Prentice Hall, 7th edition, 2013.

Semester VI

IC361	Accounting and Financial management	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: Introduction of Accounting
Meaning and Scope of accounting; Objectives, nature and functions of accounting; Advantages and limitations of accounting; Accounting as a measurement and valuation principle; Accounting Principles; Accounting as an Information System; Basis of Accounting – Cash and accrual system of Accounting; Branches of accounting; Accounting and management control.

Unit 2: Basic Accounting Process
Accounting process from recording of transactions till preparation of Trial Balance- Concept of assets, liabilities, capital, income and expenses; Balance Sheet equation; Classification of receipts/income and payments/expenditure into capital and revenue; Rules for Debit and credit; recording of transactions; The Journal and subsidiary books, ledger accounts- posting of transactions; Adjusting entry; Bank Reconciliation Statement.

Unit 3: Trial Balance and Final Accounts
Trial Balance – meaning and importance, adjusted trial balance, Difference in Trial Balance; Errors and rectification entries thereof.
Need for measurement of income, Realization principle vs. Accrual principle; accounting period, Matching revenue and expenses.
Manufacturing Account, Trading Account, Concept of Gross profit and Net profit, Need and meaning of Profit and Loss Account, Forms and contents of Profit and Loss Account, Concept of Balance Sheet, Classification of items in a balance sheet; Format of Company Balance Sheet, Preparation of Final Accounts; Cash Flow statement. Accounting for depreciation; method of inventory valuation

Unit 4: Accounting Standards and emerging concepts in Accounting
Introduction to Accounting Standards and IFRS converged Ind AS, Human Resource Accounting, Corporate Social Accounting etc.; computerized Accounting System and accounting software,

Unit 5: Study of Annual Reports of Companies; Analysis, interpretation and Judgment building
Assignment based

Text Books: -

1. Ramachandran, N. and Kakani, R.K. Financial Accounting for Management. 3/e, TATA McGraw-Hill Education Pvt. Ltd: Noida, 2011.
2. Bhattacharjee Ashis K. Financial Accounting for Business Management. Prentice Hall India: New Delhi, 2006.

Reference Books: -

1. Anthony Robert N., Hawkins David, Merchant Kenneth A., Financial Accounting-Text and Cases, McGraw-Hill Higher Education; 13 edition (1 June 2010)

ME312	Machine Design II	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: ME311

Contents

Unit 1: Introduction:
Introduction to design process, morphology of design and designing methods. (**1L**)

Unit 2: Brakes:
Types of brakes, Energy absorbed by the brakes, Design of block, band and disc brakes (Internal and external shoe); Absorption, Transmission and torsion dynamometer. (**5L**)

Unit 3: Clutches:
Classification, application and design of friction clutches, Disc or plate clutches, Cone clutches. (**5L**)

Unit 4: Power screw:
Forms of thread, I.S.O. Metric screw thread, Bolted joint in tension, Torque required for bolt tightening, Stresses in screw, Efficiency of screw. (**4L**)

Unit 5: Design of gears:
Design of spur gears, Helical gears, Bevel gears and worm gears, Lewis equation, Lewis form factor, Design based on strength dynamic and wear loads. (**10L**)

Unit 6: Introduction to design of gear boxes:
Introduction to design of gear boxes, Flywheel and Pulleys. (**2L**)

Unit 7: Bearings:
Types of bearings, Ball and **r**oller bearings, Static and dynamic load carrying capacity, Load life relationship, Taper roller bearing, Bearing materials. (**5L**)

Unit 8: Lubrications:
Basic mode of lubrication, Hydrodynamic lubrication theory, Hydrostatic and hydrodynamic bearings (e.g., Journal). (**4L**)

Unit 9: Introduction to design of IC engine components:
Cylinder, Piston, Connecting rod and Crankshafts). (**2L**)

Unit 10:
Introduction to the computer aided design. (**1L**)

(Total: 39 Lectures)

Course Outcomes (COs): -

Upon completion of this course, students will be able to

CO1: Analyze stress and strain in machine components, in particular brake, clutch, power screw, gears and bearing under different loading conditions.
CO2: Design different machine components and explain the failure of such components.
CO3: Recognize the need for friction drives and positive drives
CO4: Determine load carrying capacity and related parameters of bearing.
CO5: Predict the frictional behaviour at the sliding interface in mechanical system.

Text Books: -

1. Bhandari, V. B. Design of Machine Elements. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 3rd edition, 2014.
2. Gope, P. C. Machine Design: Fundamentals and Applications. PHI Learning Pvt. Ltd., New Delhi, 2012.

Reference Books: -

1. Bhandari V. B. Machine Design: Data book. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 2014.
2. Shigley, J.E., Mischke, C.R., Budynas, R.G., and Nisbett, K.J. Mechanical Engineering Design. Tata McGraw-Hill, New Delhi, 2008.
3. Faculty of Mechanical Engineering – PSG College of Technology, Design Data (Data book of Engineering). Kalaikathir Achchagam, 8th edition, 2007.
4. Ramamurti, V. Computer Aided Mechanical Design and Analysis. Tata McGraw Hill, 3rd edition, 1996.
5. Burr, A. H. and Cheatham, J. B. Mechanical Analysis and Design. Prentice Hall Inc., 2nd edition, 1997.
6. Dixon, J. R. Design Engineering: Inventiveness, Analysis and Decision Making. TMH, New Delhi, 1980.

ME316	Computer-Aided Engineering	L-T-P-Cr-CH: 1-0-2-3-5	Prerequisites: Nil

Contents

Unit 1: Introduction to Computer-Aided Modeling: Basic drafting, Modelling of parts and assembly drawing using standard software packages **(2 L + 3 P).**

Unit 2: Introduction to Structural Analysis: Introduction to Finite Element Analysis: Basic engineering analysis of Beams, Trusses, Plates; Stress analysis of structure with individual and combined loading under Mechanical, Thermal and Thermo-Mechanical loading **(5 L + 3 P)**.

Unit 3: Introduction to Computational Fluid Dynamics: Mathematical nature the governing partial differential equations (PDEs) for fluid flow and heat transfer, Introduction to Finite Difference Method (FDM) and Finite Volume Method (FVM), Preprocessor, Solver and Postprocessor of a commercial CFD package, SIMPLE Algorithm, RANS Based Turbulence Models, Shear Stress Transport Model, Near Wall Treatment **(5 L + 2 P)**.

Unit 4: Modeling of fluid systems: Geometry modeling using a standard commercial package, specification of boundary conditions, free-stream conditions and flow properties, user-defined functions **(2 L + 2 P)**

Use of commercial fluid-flow solvers to solve the following problems **(16 P)**:

1. Steady and unsteady-state temperature profiles in solids under heat conduction
2. Solution of viscous, laminar, incompressible flow over immersed bodies – car bodies, airfoils
3. Solution of viscous, laminar, incompressible flow through internal passages – nozzles, flow through check valves
4. Simulation of flows through Heat exchangers- conjugate heat transfer problems
5. Estimation of Nusselt number in forced, free and mixed-convection problems,
6. Computation of viscous-supersonic flows over wedges and cones
7. Simulation of Oil-Tank Sloshing
8. Simulation of pulsating flows through mufflers

9. Modeling and analysis of beams under different loading conditions using FEM
10. Modeling of different machine components using standard software package
11. Analysis of those machine components using FEM
12. Modeling of complex structures using standard software package
13. Analysis of complex structures using FEM

(Total: 14 lectures + 26 practical classes)

Course Outcomes (COs): -

On the successful completion of the course a student will be able to:

CO1: Model and analysis of physical system involving structural and thermal applications
CO2: Use commercial-software packages to simulate engineering problems involving structural loading, fluid flow and heat transfer.

Reference Books: -

1. Bhat, N. D. and Panchal V. M., Machine Drawing. Charotar Publishing House, Court Road, Anand, India, 48th Edition, 2013.
2. Srinivas, P., K., Sambana, C. and Datti, R. J., Finite Element Analysis using ANSYS@ 11.0. PHI, New Delhi, 2012.
3. Versteeg, H. K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method. Pearson, 2nd Edition, 2009.
4. Anderson, D. A., Tannehill, J. C., and Pletcher, R. H., Computational Fluid Mechanics and Heat Transfer. CRC Press, 3rd Edition, 2012.
5. Munford, P. and Normand, P. Mastering Autodesk Inventor 2016 and Autodesk Inventor LT. John Wiley Sons, 2016.
6. Kent, L.L. ANSYS Workbench Tutorial Release 14. SDC Publications, 2012.
7. ANSYS FLUENT Tutorial guide Release 15.0. ANSYS Inc., 2013.

ME317	**ME Lab (Thermal) III**	**L-T-P-Cr-CH: 0-0-2-2-4**	**Prerequisites: ME205, ME209**

Contents

Unit 1: Fluid Mechanics:
Demonstration of Bernoulli's Theorem, Flow meter demonstration: Determination of discharge coefficients of flow meters (Venturimeter and Orificemeter), Study of Impact of jet on flat, curved and semispherical surfaces, Osborne Reynolds demonstration **(8P)**

Unit 2: Turbomachinery:
Demonstration of Centrifugal pump: (i) Introduction to pump characteristic, (ii) Effect of inlet head on pump performance, (iii) System characteristic analysis (determination of operating point), Demonstration of Pelton Turbine: (i) Comparison of Pelton wheel performance using spear and throttle valve **(6P)**

Unit 3: Heat Transfer:
Demonstration of Conduction, Convection and Radiation mode of heat transfer.
Conduction: Thermal conductivity of insulating slabs
Convection: To determine heat transfer co–efficient for forced convection, dropwise and filmwise condensation apparatus and critical heat flux in pool boiling apparatus, Heat transfer in vertical cylinder natural convection apparatus

Radiation: Stefan Boltzmann apparatus
Heat exchangers, and Heat pipe: To study the heat transfer phenomena in parallel/counter flow arrangements and calculate overall heat transfer coefficient with concentric tube heat exchanger, Effectiveness of shell and tube heat exchanger apparatus, Heat pipe demonstrator, Cooling tower test rig. **(9P)**

Unit 3: Refrigeration and Air Conditioning:
Demonstration of working of refrigerating and air conditioning
system: To determine the Coefficient of performance for Vapour compression refrigeration system, Vapour absorption refrigeration system. To determine psychometric properties using Air conditioning test rig. **(4P)**

(Total: 27 Practical's)

Course Outcomes (COs): -

After successful completion of course the students will be able to:

CO1: Understand and apply the laws of fluid mechanics to practical applications
CO2: Understand the basic laws of heat transfer.
CO3: Understand the fundamentals of convective heat transfer process, like boiling, condensation.
CO4: Understand the working of refrigeration system and psychometric processes.

Reference Books: -

1. Chakrabarty, S., Som, S. K. and Biswas, G. Introduction to Fluid mechanics and fluid machines. Tata McGraw Hill, 3rd edition, 2012
2. Massey, B.S. and Smith, J. W. Mechanics of fluids. Taylor and Francis, 9th edition, 2012.
3. Incropera, F.P. and Dewitt, D.P. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, 5th edition, 2009.
4. Stoecker, W.F and Jones, J.W., Refrigeration and Air Conditioning. McGraw-Hill International Editions, 2nd edition,1986
5. White, F. M. Fluid Mechanics. Tata McGraw Hill, 7th edition, 2010
6. Kundu, P.K. Cohen, I.M. and Dowling, D.R. Fluid Mechanics. Elsevier, 5th edition, 2012
7. Ozisik, M.N. Heat Transfer-A Basic Approach. McGraw Hill, 1985.
8. Bejan, A. Convective Heat Transfer. John Wiley and Sons, New York, 3rd edition, 2004.
9. Arora, C.P. Refrigeration and Air Conditioning. Tata McGraw-Hill, 2nd edition, 2000.

ME318	Mini Project	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: Nil

Contents

The students will carry out mini projects in groups of 2 or 3 students under the supervision of a faculty member or joint supervision by some Industry Personnel. The Mini Project is likely to be extended as the final-year project work of the individual groups

Course Outcomes (COs): -

successful completion of the course students will be able to:
CO1: Develop innovative thinking and skills required for final-year project execution.
CO2: Apply the principles of science and engineering for project identification and development.
CO3: Demonstrate effective team work, sense of ownership and project planning.
CO4: Communicate and report effectively project activities and findings.

Semester VII

ME401	Industrial Systems Engineering	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: Industrial Engineering:
Introduction, Production Planning and Control, Product design, Value analysis and value engineering, Plant location and layout, Equipment selection (**8 lectures)**

Unit 2:
Plant location and layout; Equipment selection, Maintenance planning; Job, batch and flow production method, Group technology, Work study, Time and Motion study; Work/Job Evaluation, Inventory control
(8 lectures)

Unit 3: Concept of TPM and TQM, Job, batch, and flow production methods, Group technology, Work study, Time and motion study, Incentive schemes, Work/job evaluation, Inventory control-deterministic model only (8 **lectures)**

Unit 4: Manufacturing planning: MRP, MRP-II, JIT, CIM, Quality control - Statistical process control, Acceptance sampling, Total quality management, Quality engineering; (**6 lectures)**

Unit 5: Forecasting, Scheduling and loading, Line balancing, Break-even analysis, Network Analysis – PERT and CPM, Inventory Control (**10 lectures)**

(Total: 40 lectures)

Course Outcomes (COs): -

Upon the completion of the course, the students will be able to:

CO1: Explain the basic underlying concepts of product design, plant layouts, and value analysis.

CO2: Create and solve problems related to Forecasting, Scheduling, Network analysis and breakeven analysis.

CO3: Explain the mechanisms of Maintenance planning, Quality control, Inventory control and Operations Research.

CO4: Apply and analyze various techniques of sales forecasting, linear programming transportation problem, and queuing theory for solving industrial problems.

CO5: Explain the basic underlying concepts of product design, plant layouts, and value analysis.

Text Books: -

1. Telsang, M. T. Industrial Engineering and Production Management. S Chand and Company Limited, 2nd edition, 2006.
2. Paneerselvam, R. Productions and Operations Management. PHI learning Pvt. Ltd, 3rd edition, 2012.

Reference Books: -

1. Sharma, S. K. and Sharma, S. Industrial Engineering & Organization Management. S. Kataria and Sons, 3rd edition, 2016.

ME471	Industrial Summer Training	L-T-P-Cr-CH: 0-0-0-2-0	Prerequisites: Nil

Contents

Training will be of 12 weeks duration carried out during the summer break after the 6th semester.

The students will submit their reports in the 7th semester.

Course Outcomes (COs): -

At the end of the Industrial Summer Training CO1: Students will be able to acquaint themselves with the contemporary industrial practices and research.

CO2: Students will be able to establish the important links between theoretical study and practical engineering operations and problem solutions.
CO3: Students will be able to develop confidence in dealing with newer engineering environment.
CO4: Students will be able to perform their task efficiently in relevant engineering based organisations in the near future.
CO5: Students will be able to identify and work on problems of engineering interest while opting for higher studies.

ME483	**Project I**	**L-T-P-Cr-CH: 0-0-4-4-8**	**Prerequisites: ME318**

Contents

The students will carry out project works in groups of 2 or 3 students each under the guidance of a faculty member or joint supervision with some Industry Personnel. The project shall consist of research/ design/ development/ implementation work.

Course Outcomes (COs): -

On successful completion of the course, the students will be able to:
CO1: Demonstrate a sound technical knowledge on the project topic.
CO2: Identify, formulate and solve complex engineering problem.
CO3: Design engineering solutions to complex problems using modern tools and techniques.
CO4: Display of effective team-work and project-planning.
CO5: Communicate with engineers and the community at large in written and oral forms.
CO6: Acquire the knowledge, skills and attitudes of a professional engineer.

Semester VIII

ME484	**Project II**	**L-T-P-Cr-CH: 0-0-8-8-16**	**Prerequisites: ME483**

Contents

The students will carry out project works in groups of 2 or 3 students each under the guidance of a faculty member or joint supervision with some Industry Personnel. A provision is present for a group to work for the entire semester in some Industry, if suitable opportunity arises. In that case the concerned students will be allowed to complete the course works for ME Elective VI and Open Elective IV through MOOCs. The project shall consist of research/ design/ development/ implementation work.

Course Outcomes (COs): -

On successful completion of the course, the students will be able to:
CO1: Demonstrate a sound technical knowledge on the project topic.
CO2: Identify, formulate and solve complex engineering problem.
CO3: Design engineering solutions to complex problems using modern tools and techniques.
CO4: Display of effective team-work and project-planning.
CO5: Communicate with engineers and the community at large in written and oral forms.
CO6: Acquire the knowledge, skills and attitudes of a professional engineer.

ME 422	Optimization Methods in Engineering	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Classical optimization methods, unconstrained minimization.

Unit 2: Univariate, conjugate direction, gradient and variable metric methods, constrained minimization.

Unit 3: Feasible direction and projections.

Unit 4: Integer and Geometric programming.

Unit 5: Genetic Algorithms; Simulated Annealing Techniques.

Unit 6: Design Applications.

ME 428	Finite Element Methods in Engineering	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction to FE method:
The basic concept of FEM, Historical background, Need of FEM, Applications, advantages, and limitations of FEM, Real-life application of FEM with PPT presentation.

Unit 2: Analysis of 1D problem:
Different approaches in FEM: General steps of FE method, Direct approach, Direct formulation of an axial rod problem, solving of problems using the direct approach.

Unit 3: Analysis of Truss:
Derivation of the element stiffness matrix of truss element, Global stiffness matrix, Solution of truss problems.

Unit 4: Finite elements and Interpolation function (IF):
Shape functions, Pascal pyramid for polynomial, Line elements, Lagrangian form of IF, Length coordinate for higher-order element,
Finite element formulation of bar and beam elements; Derivation of the element stiffness matrix for bar and beam elements, Solution of bar and beam problems.

Unit 5: Analysis of 2D problems:
Triangular elements, Area coordinates, Shape function of the triangular element, rectangular elements, Shape function of the rectangular element, Serendipity approach, Isoparametric formulation, Coordinate transformation, Solution of triangular and rectangular elements.

Unit 6: Introduction to the calculus of variation:
Calculus of variation, Functional, Exetremization of functional, Properties of variational operation, Variational form from a differential equation, Solution of problems.

Unit 7: Approximate methods of analysis:
Different types of approximate methods, Ritz method, Method of weighted residual, Galerkin's method, solving problems using Ritz and Galerkin method.

Unit 8: Numerical integration:
Need of numerical integration in FEM, Gauss Quadrature in 1D and 2D, Solving problems using Gauss Quadrature rule.

Unit 9: Assignments:
Modelling and analysis of structural components using the commercial FE software package.

Text Books: -

1. Desai YM, Eldho TI, and Shah AH. Finite Element Method with Applications in Engineering, Pearson, 2019
2. Dixit US. Finite Element Methods for Engineers, Cengage Learning, 2018.

Reference Books: -

1. Seshu P. Textbook of Finite Element Analysis, Prentice-Hall India, 2014.
2. Chandrupatla TR and Belegundu AD. Introduction to Finite Elements in Engineering, Pearson, 4t ed., 2019.
3. Huebner KH, Dewhirst, DL, Smith DE and Byrom TG. The Finite Element Method for Engineers, WileyInterscience, 4th ed., 2001.
4. Hutton DC. Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005.
5. Reddy JN. An introduction to the Finite Element Method, Tata McGraw-Hill, 2006.

ME429	Gas Turbine and compressor	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Contents

Unit 1: Introduction:
Development, classification and field application of gas turbine.

Unit 2: Gas Turbine Cycle:
Ideal and actual cycles, multi-stage compression, reheating, regeneration, combined and cogeneration.

Unit 3: Energy transfer and fluid flow characteristics:
Energy transfer between fluid and rotor, axisymmetric flow in compressor and gas turbine.

Unit 4: Centrifugal Compressor:
Principles of operation; compressor losses adiabatic efficiency; slip factor; pressure coefficient; power unit; design consideration for impeller and diffuser system; performance characteristics.

Unit 5: Axial Flow Compressors:
Elementary theory; vortex theory; degree of reaction; simple design; elementary air-foil theory; isolated air foil and cascade theory; three-dimensional flow; stages; stage efficiency and overall efficiency; performance characteristics.

Unit 6: Turbines:
Axial flow and radial flow turbine; impulse and reaction turbine; fundamental relations and velocity triangles; limiting factors in turbine design; application of air foil theory to the study of flow through turbine blades; aerodynamic and thermodynamics design consideration; blade attachments and blade cooling.

Unit 7: Gas Turbine Power Plants:
Fuel and fuel feed system; combustion system-design considerations and flame stabilization regenerator types and design; gad turbine power; plant performance and matching; application.

Course Outcomes (COs): -

Upon the completion of the course, the students will be able to:
CO1: Discuss the basic energy equation and thermodynamics law behind the gas turbine
CO2: Understand the improvements brought to gasturbine plants in terms of performance.
CO3: Evaluate the performance characteristics of gas turbines under different operation conditions
CO4: Analyze the surging and choking conditions of compressor and gas turbine
CO5: Discuss the elementary theories for compressor and turbine.
CO6: Design the gas turbine units and its blades.

Text Books: -
1. Cohen and Rogers. Gas Turbine Theory (Longman, 4/e, 1996)
2. Dixon, S.L. Fluid Mechanics, Thermodynamics of Turbomachinery (Pergamon Press, 5/e, 2005).

Reference Books: -
1. Vincent, Theory & Design of Gas Turbine and Jet Engines (McGraw Hill, 1950)
2. Gas Turbine Principles and Practice (Cox Newnes, 1955)

ME 434	Composite Materials	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction:
Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.

Unit 2: Reinforcements Materials:
Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Nonwoven random mats. Course Code Course Name Lecture Tutorial Practical Credit ME 434 COMPOSITE MATERIALS 3 0 0 3 Types of matrix: Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Intermetallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.

Unit 3: Production techniques and Properties:
Processing of cast composites - XD process, Spray processes (Osprey Process, Rapid solidification processing), In-situ Dispersion Processes (Stir-casting & Compo casting, Screw extrusion), Liquidmetal impregnation technique (Squeeze casting, Pressure infiltration, Lanxide process). Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.

Unit 4: Mechanics of Composite Materials:
Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress vs. strain curves for different composite materials. Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4-point bend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.

Unit 5: Recent developments in Composites:
Self-healing composites, Molecular composites, Micro and Nanocomposites, Biocomposites, Left-handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).

Text Books: -
1. Chawla K.K., Composite materials, Springer, New York, 1998.

Reference Books: -
1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.
2. Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
3. Sharma S.C., Composite materials, Narosa Publications, 2000.
4. Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.

ME 436	Combustion Engineering	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction:
Historical perspective – fuels and combustion technology, types and general characteristics of fuels, fuel analysis - proximate and ultimate analysis, moisture and heating value determination – gross and net heating values – calorimetry, DuLong's formula for HV estimation, flue gas analysis – Orsat apparatus.

Unit 2: Thermodynamics and kinetics of combustion:
Properties of mixture, combustion stoichiometry, chemical energy, chemical equilibrium; properties of combustion products, first law combustion calculations – adiabatic flame temperature (analytical and graphical methods), second law analysis, chemical kinetics-elementary reactions, chain reactions, pre-ignition kinetics, global reactions, kinetics reaction at solid surface.

Unit 3: Combustion of solid fuels:
Drying, devolatilization, char combustion, fixed bed combustion, suspension burning, fluidized bed combustion.

Unit 4: Combustion of liquid and gaseous fuels:
Spray formation and droplet behaviour - oil fired furnace combustion - gas turbine spray combustion – direct and indirect Injection combustion in IC engines, droplet evaporation and burning, energy balance and furnace efficiency, gas burner types, pulse combustion furnace, premixed charge engine combustion, detonation of gaseous mixtures, 1-D detonation theory, detonation velocity.

Unit 5: Laminar premixed flames:
Definition, assumptions, governing equations, boundary conditions, flame speed, quenching, flammability limits, flame stability.

Unit 6: Turbulent premixed and non-premixed flames:
Definition, flame speed, flame regimes, flame stability, analysis of jet flames, flame length, blowout.

Unit 7: Emission control:
Methods of emission Control-exhaust gas recirculation in IC engines, catalytic converters, electrostatic precipitators, secondary air injection, emission indices, emissions from premixed and non-premixed combustions.

Course Outcomes (COs): -

CO1: Analyze fuel characteristics by selecting suitable methods.
CO2: Calculate combustion parameters using chemical kinetics, combustion stoichiometry and combustion thermodynamics.
CO3: Apply the acquired knowledge of solid fuel combustion during fixed and fluidized bed combustion operations.
CO4: Solve real life problems of combustible droplets, injection and detonation by matching with the acquired theoretical concepts.
CO5: Measure flame characteristics for the design of combustion devices.
CO6: Assess the suitability of emission control devices to control the harmful effects of pollution in the society.

ME 439	Refrigeration and Air Conditioning	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Vapour-compression cycles; Absorption refrigeration; Vapour-compression-system analysis; Air-Craft refrigeration cycle; multi-pressure systems; Refrigerants; Condensers and evaporators; Compressors; Expansion devices, Psychrometry, Psychrometric Processes; Heating- and cooling-load calculations; Air-conditioning systems; Fan and duct systems; Pumps and pumping; Cooling and dehumidifying coils; Air-conditioning controls; Heat pumps; Cooling towers and evaporative condensers.

CO1: Illustrate the fundamental terminology associated with refrigeration and air conditioning
CO2: Understand the components of vapour compression systems and other types of cooling systems and analyse the performance using Mollier charts
CO3: Evaluate the properties, applications and environmental issues of different refrigerants
CO4: Apply the concept of thermodynamic laws and heat transfer to understand the components of refrigeration and air conditioning
CO5: Analyze the air conditioning processes using principles of Psychrometry
CO6: Evaluate cooling and heating loads in an air conditioning system

Text Books: -

1. Stoecker, W.F and Jones, J.W., Refrigeration and Air Conditioning (McGraw-Hill International Editions, 3/e, 1986.
2. Threkeld, J.L. Thermal Environmental Engineering (Prentice Hall Inc, 2/e., 1970).

Reference Books: -

1. Arora, C.P. Refrigeration and Air Conditioning (Tata McGraw-Hill, 2/e, 2000).
2. Air conditioning Design Handbook (Carrier Corpn, McGraw Hill, 1965)
3. ASHRAE Handbooks (ASHRAE, 2007)

ME 440	Advanced Mechanics of Solids	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Analysis of stress:
Introduction, Cauchy's formula, Principal stress, Stress invariants, 3D Mohr's circle, Octahedral stresses, Hydrostatic and deviatoric stress, Differential equations of equilibrium in rectangular and cylindrical coordinate, Stress boundary conditions, Plane stress and Plane stress Problems, Airy's stress function.

Unit 2: Analysis of strain:
Introduction, Definitions of normal and shear strain, Principal strain, Strain invariants, Plane strain in rectangular and polar coordinates, Compatibility conditions.

Unit 3:
Generalized Hooke's law and theories of failure.

Unit 4: Energy Methods:
Introduction, Principal of superposition, Elastic strain energy and complementary energy, Reciprocal relations, Maxwell-Betti theorem, Castigliano's theorem, Virtual work principal, statically indeterminate structures, Kirchoff's theorem.

Unit 5: Bending of beams:
Bending of symmetric and unsymmetrical beams, curved beam, Shear stresses in beams, shear centre.

Unit 6: Torsion:
Torsion of circular and non-circular sections.

Unit 7: Axisymmetric Problems:
Thick and thin-walled cylinders, Composites tubes, Rotating disks and cylinders.

Unit 4: Elastic Stability:
Euler's buckling load, Eigenvalue problem.

Text Books: -
1. Srinath L.S., "Advanced Mechanics of Solids" 2 nd Edition, TMH Publishing Co. Ltd. New Delhi

Reference Books: -
1. Budynas, R.G., "Advanced Strength and applied stress analysis" 2nd Edition, McGraw Hill Publishing Co.
2. Boresi, A.P., Schmidt, R.J., "Advanced mechanics of materials" 6th Edition, John Willey & Sons Inc.
3. Raymond, P., "Solid Mechanics in Engineering" 1st Edition, John Willey & Sons.

ME-503	Mechanics of Composite Materials	L-T-P-Cr-CH: 3-1-0-4-4	

Contents

Unit 1: Introduction:
classifications, terminologies, manufacturing processes and applications of composite materials;

Unit 2: Macro-mechanical behavior of lamina:
stress-strain relations, engineering constants for orthotropic materials, transformation of stress and strain, strength and stiffness of lamina, biaxial strength theories;

Unit 3: Micro-mechanical behavior of lamina:
volume and mass fractions;

Unit 4: Macro-mechanical behavior of laminates:
single-layered configurations, symmetric laminates, anti-symmetric laminates, strength of laminates;

Unit 5:
Hygro-thermal analysis of lamina and laminates;

Unit 6: Design of laminates:
symmetric, cross-ply, angle-ply and anti-symmetric laminates;

Unit 7: Failure analysis:
failure criteria and failure modes, buckling and vibration of laminated beams, plates and shells; Assignment and mini-project.

Text Books: -
1. Daniel, I.M. and Ishai, O. Engineering Mechanics of Composite materials (Oxford University Press, 2005)
2. Jones, R.M. Mechanics of Composite Materials (Taylor & Francis, 1999)

Reference Books: -
1. Agarwal, B.D., Broutman, L.J. and Chandrashekhara, K. Analysis and Performance of Fiber Composites (John Willey &Sons, 2006)
2. Kaw, A.K. Mechanics of Composite Materials (Taylor & Francis, 2006) 3. Reddy, J.N. Mechanics of Laminated Composite Plates (CRC Press, 1997)

ME-504	Failure Analysis of Materials	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction:
common causes of failure, failure investigation, principle of failure analysis.

Unit 2: Fracture mechanics:
energy approach and stress intensity factor approach to linear elastic fracture mechanics, concept of crack tip opening displacement and J-integral fracture criteria, mechanisms of fracture, evaluation of fracture toughness, fracture in composite materials, computational fracture mechanics analysis, fracture mechanics in nano materials and structures.

Unit 3: Creep:
stress-tiMEtemperature relations, creep curve.

Unit 4: Fatigue:
stresses in cyclic loading, fatigue testing, S-N curves and endurance limit, mechanisms of fatigue crack initiation and propagation, influence of stress concentration on fatigue strength, notch sensitivity, factors influencing fatigue behavior, prevention of fatigue failure.

Unit 5:
Assignment and mini-project.

Text Books: -
1. Kumar, P. Elements of Fracture Mechanics (McGraw-Hill, 2009)
2. Anderson, T.L. Fracture Mechanics: Fundamentals and Applications (CRC Press, 2004)

Reference Books: -
1. Bruck, D. Elementary Engineering Fracture Mechanics (Springer, 1986)
2. Barson, J.M. and Rolfe, S.T. Fracture and Fatigue Control in Structures (Butterworth-Heinemann, 1999) 3. Dieter, G. Mechanical Metallurgy (McGraw-Hill, 1986)
4. Calister, W.D. Material Science and Engineering: An Introduction (John Wiley & sons, 2009)
5. Gdoutos, E.E. Fracture of Nano and Engineering Materials and Structures (Springer, 2006)

ME 523	**Non-Conventional Energy**	**L-T-P-Cr-CH: 3-0-0-3-3**	

Contents

Unit 1: Introduction:
Importance of non-conventional energy, sources of non-conventional energy and their application. Advantages of non-conventional energy over fossil fuel.

Unit 2: Biomass energy:
types of biomasses- plant waste and animal waste, conversion techniques of biomass into energy, biogas plant, modern techniques of biomass conversion, advantages and disadvantages of biomass energy, gobar gas.

Unit 3: Hydroelectric energy:
mechanism of hydroelectric power generation, hydroelectric dam, sizes and capacities of hydroelectric plant, present and future scenario of hydroelectric energy and its positive and negative aspect in society.

Unit 4: Wind energy:
types of wind turbine, wind mill, offshore and onshore wind power, capacity factor. Solar energy: Application of solar energy as heating electricity generation and fuel production, solar panel, development of solar energy techniques, energy storage methods.

Unit 5: Tidal power:
tide mills, generating method of tidal power, tidal barrage and dynamic tidal power, tidal power issues ecological and corrosion.

Unit 6: Geothermal energy:
geothermal gradient, hot springs, electricity generation, direct application of geothermal energy, environmental effects.

Unit 7: Fuel cell:
types of fuel cell, Phosphoric acid fuel cell (PAFC), high temperature fuel cell-SOFC, MCFC, application-fuel cell electric vehicle (FCEV), Hydrogen energy.

Course Outcomes (COs): -

CO1: Identify the various sources of renewable energy.
CO2: Identify the components of renewable energy systems.
CO3: Apply the acquired theoretical concepts of various non-conventional energy system components in practice.
CO4: Apply the acquired knowledge in the design and process arrangements of non-conventional energy systems.
CO5: Evaluate the impact of the use of renewable energy in the society.
CO6: Identify and solve problems of non-conventional energy systems.

Reference Books: -

1. Non-Conventional Energy Resources, B H Khan, McGraw Hill Education (India) Private Limited, New Delhi.
2. Non-Conventional Energy Resources, G S Sawhney, PHI Learning, Delhi.
3. Reviews of Renewable Energy Sources, M S Sodha, S S Mathur, and M A S Malik, Wiley Eastern. New Delhi.
4. Renewable energy technologies, R Ramesh, Narosa Publishing House, New Delhi
5. Renewable energy and environment, proceedings of the National Solar Energy Convention, 1989, N S Rathore, Himanshu Publications, New Delhi.
6. Solar Energy: Principles of Thermal Collection and Storage, K Sukhatme and S P Sukhatme, Tata McGraw Hill, New Delhi.
7. Wind Energy Technology, John F. Walker and Nicholas Jenkins, John Wiley and sons Canada, Limited.

ME 527	CAD-CAM	L-T-P-Cr-CH: 3-0-0-3-3	

Course Outcomes (COs): -

CO1: Have the knowledge of computer aided design and manufacturing for solving related application-oriented problems.
CO2: Understand the advanced design and manufacturing process to cope with latest technology.
CO3: Critical thinking and critical judgment on practical implementation so as to face real life problem solving.
CO4: Interpretation on design and analysis of engineering problems and clear concept and observation.
CO5: Establish links between theoretical and practical applications in real life cases.
CO6: Undertake problem identification, formulation and solution for industrial application.
CO7: In hand practice to software packages for realistic design analysis and simulation.

ME 528	Energy Conservation and Waste Heat Recovery	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction:

Energy resources and use, energy conservation and utilization. energy conservation potential, energy conservation issues and policies, Jevon's paradox, rebound effect, energy management standards, energy audit, fossil fuels, total energy approach. sources of waste heat, importance of waste heat recovery, review of fundamental laws of thermodynamics.

Unit 2: Waste heat analysis:
Definition, properties of exhaust gases, gas-to-gas, gas-to-liquid heat recovery, waste heat application, waste heat recovery methods, utilization of industrial waste heat, heat of combustion, exergy analysis, utilization of low grade reject heat from power plants, thermo-economic optimization, emission of waste heat, emission standards and control, sorbent ranking.

Unit 3: Waste heat recovery systems:
Recuperators and regenerators, shell and tube heat exchangers, spiral tube and plate heat exchangers, run around coil, waste heat boilers, boiler specifications, single and multi-pressure HRSGs, coupled cycles and combined plants, cogeneration systems, heat recovery of ORC and Kalina cycles, heat recovery in H2 plants, waste heat recovery from diesel engines, heat recovery from incineration plants, fluidized bed heat recovery systems, thermoelectric system to recover waste heat, utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems.

Unit 4: Heat pipes:
Definition, theory and applications of heat pipes in waste heat recovery, classification, components of heat pipe and their characteristics, operating limits, operating modes, effects of pressure gradients .

Unit 5: Heat pumps:
Definition, heat pump for energy recovery, Carnot heat pump, heat pump classification, heat pump efficiency, primary energy ratio.

Unit 6: Energy storage:
Need for energy storage, thermal, electrical, magnetic and chemical storage systems.

Course Outcomes (COs): -
CO1: Explain the need of energy conservation.
CO2: Distinguish between the types of waste heat recovery systems and their components.
CO3: Examine problems associated with heat recovery systems.
CO4: Apply their knowledge and understanding to analyse and design such systems as per requirements.
CO5: Solve practical problems associated with operation of waste heat recovery systems.

Reference Books: -
1. Harlock, J.H. Combined Heat and Power (Pergaman Press, 1997)
2. Kreith, F. and West, R.E. Energy Efficiency, CRC handbook (CRC Press,1999)
3. Kays and London, Compact Heat Exchangers (McGraw-Hill, New York, 3/e, 1958)

ME 531	Project Management	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction and basic fundamental:
Importance of Project management, Project selection, Project Definition/Project Charter (SOW), Project Goal, Types of projects, Project Life-cycle model, Project stakeholders, Organizational influences, Project management processes and mapping, Project Process flow diagrams, Project idea generation and acceptance; Modelling the project system. Project analysis and feasibility report.

Unit 2: Project Scope:

scope definition, scope planning, Project Breakdown Structure (WBS), Scope verification, scope control.

Unit 3: Project Planning and Scheduling techniques, Resource Scheduling:
Resource allocation method, splitting and multitasking, Multi-project resources scheduling, Critical chain scheduling- Concept, method, application and limitations. Project integration management, PMP, Direct and manage project execution, Performance measurement and control, Project monitoring and Control, earned value method and milestone monitoring. PERT/CPM.

Unit 4:
Project Time management, activity definition, activity sequencing, resource estimating, duration estimating, schedule development and control, Project cost estimating, cost budgeting and cost control.

Unit 5:
Human resource management, HR planning, acquire, develop and manage project team, performance reporting and manage stakeholders. Project risk management. Overview of software project management. Software for project management.

Course Outcomes (COs): -
After completion of the course, students would be able to
CO1: Initiate projects with clearly identified scope, requirements, constraints, deliverables and stakeholders.
CO2: Evaluate and manage project risk.
CO3: Use structured project methodology to address complexities in projects.
CO4: Explain earned value management, milestone monitoring.

Text Books: -
1. Gray, C. F., Larson, E. W. and Desai G. V. Project Management -The Managerial Process. McGraw Hill Education Private Limited, New Delhi, 4th edition, 2010.
2. Maylor, H. Project Management. Pearson Education Limited. New Delhi, 3rd edition, 2003.

Reference Books: -
1. Chandra, P. Project Preparation, Appraisal and Implementation. Tata McGraw Hill Publishing Company, New Delhi, 7th edition, 2009.
2. Burke, Rory. Project management - Planning and Control Techniques. John Wiley & Sons, Inc., 5th edition, 2013.
3. Lientz, B. P. and Rea, K. P. Project Management – for 21st Century, Academic Press, 4th edition, 1995. 4. Heerkens, G. R. Project Management, McGraw-Hill, 2nd edition, 2013.

ME532	Power Plant Engineering	(L-T-P: 3-0-0)	Prerequisites: None

Contents

Unit 1: Introduction:
economics of power generation, load curves, load and load types, load factor, base and peak loads, reserved capacity, plant capacity, annual depreciation, energy cost calculations.

Unit 2: Steam cycle analysis:
Rankine cycle, work and heat interactions, steam and heat rate, thermal efficiency, ideal reheat and regenerative rankine cycles, feedwater heaters, deaeration, cogeneration, topping and bottoming cycles.

Unit 3: Combined cycle power generation:
working fluid, coupled cycles, series and parallel combination with heat loss, steam and other working fluids.

Unit 4: Steam Generators:
Boilers, economisers, superheaters, reheaters, air preheaters, FBB, electrostatic precipitators, boiler efficiency, blowdown.

Unit 5: Steam turbines:
high pressure and low-pressure turbines, condensing and noncondensing turbines, nozzle flow, nozzle efficiency, choked flow, impulse and reaction turbines, compounding of steam turbines, diagram efficiency, governing of steam turbines.

Unit 6: Condensers, feedwater and circulating systems:
Theory and analysis of condensers, feedwater heaters, cooling towers. .

Unit 7: Nuclear power plants:
Half-life, nuclear fission, reflectors, nuclear reactors, PWR, BWR, heavy water reactors, liquid metal fast breeder reactors.

Unit 8: Hydroelectric power plants:
Overview of pelton wheel, francis turbine, propeller and kaplan turbines, specific speed, cavitation, surge tanks, performance characteristics, turbine size, turbine selection.

Course Outcomes (COs): -
CO1: Identify the various components of a power plant.
CO2: Apply the acquired theoretical concepts of various power plant components in practice.
CO3: Identify the problems associated with power generation systems.
CO4: Assess appropriate strategy to achieve power generation economically.
CO5: Solve problems associated with power plant engineering.
CO6: Apply the acquired knowledge in the design and process arrangements of power plants.

Reference Books: -
1. Power Plant Engineering, P.K.Nag, Tata McGraw Hill Education Pvt.Ltd.,3e, New Delhi
2. Power Plant Technology, M.M.El-Wakil, McGraw Hill.
3. Power Plant Engineering, Arora & Domkundwar, Dhanpat Rai & Co., Delhi.
4. Power Plant Engineering, C.Elanchazhian, I.K. International, Delhi.
5. Power Plant Engineering, Nagpal, Khanna Publishers, Delhi
6. Boiler Operator's Handbook, Kenneth E. Heselton, Fairmont Press, Inc, 2e.
7. Thermodynamics: An Engineering Approach Hardcover – Feb 2014, M.Boles & Y. Cengel, McGraw Hill Education, 8e.

ME 534	Mechatronics	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Unit 1: Introduction:
Definition of mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics.

Unit 2: Mechatronics elements:
Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers.

Unit 3: Processors /controllers:
Microprocessors, microcontrollers, PID controllers and PLCs.

Unit 4: Drives:
Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Unit 5: Hydraulic systems:
flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits.

Unit 6: Pneumatic system:
production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Unit 7: CNC technology and Robotics:
CNC machines and part programming. Industrial Robotics.

Text Books: -

1. Boucher, T. O., Computer automation in manufacturing - an Introduction, Chapman and Hall, 1996.
2. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988

Reference Books: -

1. Deb, S. R., Robotics technology and flexible automation, Tata McGraw-Hill, New Delhi, 1994.
2. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.

ME-601	Automobile Engineering	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Historical background, Introduction to different power plant for automotive vehicles. Layout of different kind of vehicle, resistance to vehicle motion and need of gear box, various types of gear box including automatic transmission systems, clutches including fluid coupling, torque converter, rear axle and final drive differential, front axle construction with constant velocity joint, steering system, suspension and chassis, brake including regenerative braking, recent development including electric vehicle, automobile electronics control system for energy optimization and electrical appliances. Automotive aerodynamics, design and pollution control.

Textbooks

1. Crouse, W.A. and Anglin, D.L. Automotive Mechanics (McGraw-Hill, New York, 2007)
2. Jain, K.K and Asthana, R.B. Automobile Engineering (Tata McGraw Hill, New Delhi, 2004)

Reference Books: -

1. Heitner, J. Automotive Mechanics (East-West Press, London, 1999)
2. Heisler, H. Advanced Vehicle Technology (Butterworth-Heinemann, Netherlands, 2002)
3. Limpert, R. Brake Design and Safety (SAE International, Pennsylvania, 1999)
4. Reimpell, J., Stoll, H., and Betzler, J.W. The Automotive Chassis (SAE International, Pennsylvania, 2010)
5. Ehsani, M., Gao Y and Emadi, A. Modern Electric, Hybrid Electric and Fuel Cell Vehicles (CRC, London, 2010).

ME-621	Energy Conservation and Waste Heat Recovery	L-T-P-Cr-CH: 3-0-0-3-3	

Contents

Energy resources and use. Potential for energy conservation. Optimal utilization of fossil fuels. Total energy approach. Coupled cycles and combined plants. Cogeneration systems. Exergy analysis. Utilization of industrial waste heat. Properties of exhaust gas. Gas-to-gas, gas-to-liquid heat recovery systems. Recuperators and regenerators. Shell and tube heat exchangers. Spiral

tube and plate heat exchangers. Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat. Fluidized bed heat recovery systems. Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems. Thermoelectric system to recover waste heat. Heat pump for energy recovery. Heat recovery from incineration plants. Utilization of low grade reject heat from power plants. Need for energy storage: Thermal, electrical, magnetic and chemical storage systems. Thermo-economic optimization.

Reference Books: -

1. Harlock, J.H. Combined Heat and Power (Pergaman Press, 1997)
2. Kreith, F. and West, R.E. Energy Efficiency, CRC handbook (CRC Press,1999)
3. Kays and London, Compact Heat Exchangers (McGraw-Hill, New York, 3/e, 1958)