ACADEMIC REGULATIONS, COURSE STRUCTURE & SYLLABUS

For

B.Tech.

MECHANICAL ENGINEERING

(*Applicable for batches admitted from 2019-20*)

PRAGATI ENGINEERING COLLEGE

(AUTONOMOUS)

Permanently Affiliated to JNTUK, Kakinada, Accredited by NAAC with "A" Grade
Recognized by UGC 2(f) and 12(b) under UGC act, 1956
1-378, ADB Road, Surampalem – 533 437
Near Peddapuram, E.G.Dist, Andhra Pradesh

R19-ACADEMIC REGULATIONS FOR B.TECH (REGULAR)

Applicable for the students of B.Tech (Regular) Admitted from the academic year 2019-2020.

1. AWARD OF B.TECH DEGREE

A Student shall be declared eligible for the award of B.Tech Degree if he/she fulfills the following academic regulations.

1.1 A Student shall be declared eligible for the award of the B.Tech Degree, if he/she pursues a course of study for not less than four and for not more than eight academic years.

1.2 The candidate shall register for 160 credits and secure all the 160 credits.

2. PROGRAMMES OF STUDY

Following B.Tech Programmes are offered with English as medium of instruction.

S. No.	Name of the Programme	Code
1	Civil Engineering (CE)	01
2	Electrical and Electronics Engineering (EEE)	02
3	Mechanical Engineering (ME)	03
4	Electronics and Communications Engineering (ECE)	04
5	Computer Science and Engineering (CSE)	05
6	Information Technology (IT)	12

3. INDUCTION PROGRAMME.

At the beginning of the first year in the zero semester there shall be three weeks induction programme to help new students adjust and feel comfortable in the new environment, inculcate in them the culture of the institution.

4. DISTRIBUTION AND WEIGHTAGE OF MARKS

4.1 The performance of a student in each semester shall be evaluated subject – wise with a maximum of 100 marks for theory/drawing/design courses and 75 marks for laboratory courses. The project work shall be evaluated for 200 marks. The mini project/Socially relevant activity has a weightage of 50 marks and evaluated internally.

4.2 Theory Courses

a) Internal assessment: 30 marks

For the Mid examinations there shall be two tests, one conducted in the middle and the other at the end of each semester. Each mid examination consists of an examination and assignment. The question paper contains **Part-A** and **Part-B**. The duration for the answering the question paper is 100 minutes. For first Mid examination Part-A consists of three questions, one question from first unit, one question from second unit each for 8 marks and one question from first half of third unit for 4 marks. For second Mid examination Part-A consists of three questions, one question from second half of third unit for 4 marks, one question from fourth unit and one question from fifth unit each for 8 marks. Part-B consists of ten objective type questions each carries half mark totaling to 5 marks. Answering all questions is compulsory.

Students shall submit two assignments in a semester. The first assignment will be on first two units and first half of the third unit. The second assignment will be on the second half of third unit and last two units. The marks allotted for each assignment is 5.

Internal Marks based on mid examinations including assignments (30 Marks) are calculated with 80% weightage for best of the two mid examinations and 20% weightage for other mid examination.

The formula for finding the total marks of internal assessment (30 marks) = [0.80 x higher marks scored between the two internal tests + 0.20 x marks scored in the other test]

b) External assessment: 70 Marks

The end semester examination is of 3 hours duration and it covers the topics in 5 units and weightage is 70 marks.

End examination consists of 5 questions and each question for 14 marks. Two Questions from each unit with internal choice i.e., either or choice (total 10 questions with 2 questions from each unit)

4.3 Laboratory Courses

a) Internal assessment: 25 marks

There shall be continuous evaluation during the semester for 25 marks as shown below:

Day-to-Day work	-	10 marks
Laboratory record	-	5 marks
One internal test at the end of the semester	-	10 marks
Total	-	**25 Marks**

b) External Assessment: 50 marks

At the end of the semester an examination for 3 hours duration shall be conducted for 50 marks by the concerned teacher and an external examiner.

4.4 Drawing/Similar Course

i) For Engineering Drawing course,

a) Internal assessment: 30 marks

There shall be continuous evaluation with a weightage of 30 marks as shown below :

Day-to-Day work	-	15 marks
Internal tests : There shall be two internal tests One in the middle of the semester and the other at the end. Marks for Internal Tests = 0.8 x higher marks scored between the two tests + 0.2 x marks scored in the other test.	-	15 marks
Total	-	**30 Marks**

b) External assessment: 70 Marks

Same as for theory courses given in 4.2 (b)

ii) For Machine Drawing course,

a) Internal assessment : 30 marks

There shall be continuous evaluation with a weightage of 30 marks as shown below :

Day-to-Day work	-	15 marks
Internal tests : There shall be two internal tests One in the middle of the semester and the other at the end. Marks for Internal Tests = 0.8 x higher marks scored between the two tests + 0.2 x marks scored in the other test.	-	15 marks
Total	-	**30 Marks**

b) External assessment: 70 Marks

The end semester examination is of 3 hours duration and it covers the topics in two parts and weightage is 70 marks.

End examination consists of two parts i.e PART-A and PART-B. PART-A consists of 3 questions and out of which two questions are to be answered and each carry 14 marks. PART-B contains one compulsory question for 42 marks.

iii) Courses such as Building Planning and Drawing, Design and Detailing of Reinforced Concrete Structures, Design and Detailing of Steel Structures, Estimation, Specifications and Contracts.

a) Internal assessment: 30 marks

There shall be continuous evaluation with a weightage of 30 marks as shown below :

Assignments	-	10 marks
Internal tests : There shall be two internal tests One in the middle of the semester and the other at the end. Marks for Internal Tests = 0.8 x higher marks scored between the two tests + 0.2 x marks scored in the other test.	-	20 marks
Total	-	**30 Marks**

b) External assessment: 70 Marks

The end semester examination is of 3 hours duration and it covers the topics in 5 units and weightage is 70 marks.

End examination consists of two parts i.e., PART-A and PART-B. PART-A consists of 2 questions and out of which one question has to be answered and carries 28 marks. PART-B contains 5 Questions out of which three questions has to be answered and each carry 14 marks.

4.5 Socially Relevant Activity

To enhance social responsibility among students a Socially relevant Activity is introduced in the II year I / II semester. Each student has to participate in various social awareness programmes viz. Swach Bharat, Water Harvesting, Health and Hygiene. Each student has to work 15 hours continuously in the semester for this work. It has a weightage of 50 marks and evaluated internally at the end of the semester.

4.6 Mini Project

There shall be a Mini Project in the III year I/II semester. It has a weightage of 50 marks and evaluated internally at the end of the semester.

4.7 Project Work

Out of a total of 200 marks for the Project work, 60 marks shall be for Internal Evaluation and 140 marks for the End Semester Examination. The End Semester Examination (Viva-voce) shall be conducted by the committee. The committee consists of an external examiner, Head of the Department and Supervisor of the Project. The Evaluation of project work shall be conducted at the end of the IV year. The Internal Evaluation shall be on the basis of two seminars given by each student on the topic of his project and evaluated by an internal committee.

4.8 Mandatory Audit/Non-Credit Courses

Following are the mandatory audit courses offered to all the programmes.

i. Environmental Science
ii. Constitution of India
iii. Essence of Indian Traditional Knowledge
iv. Professional Ethics and Human Values
v. IPR and Patents
vi. MOOCs/Industry course approved by the department.

4.8.1 Evaluation Procedure:

4.8.1.1 Mandatory Audit/Non-Credit Courses (i - v):

For the Mandatory Audit/Non credit courses i-v listed above an internal test shall be conducted at the end of the semester. A student is required to score minimum 40 marks out of 100 marks in each of the mandatory audit/non credit courses.

4.8.1.2 MOOCs Course/ industry course approved by the department:

A student shall register either MOOCs or industry course approved by the department.

i. MOOCs:

There shall be a Discipline Centric mandatory Course through Massive Open Online Course (MOOC). The student shall register for the course (Minimum of 8 weeks) offered by authorized Institutions/Agencies through online with the approval of Head of the Department which is not covered in the curriculum. For those students who have not cleared the online MOOCs course, respective Head of the Department shall appoint one mentor for each of the MOOC subjects offered and the mentor appointed shall conduct an internal test. A student is required to score 40 marks out of 100 marks.

ii. Industry course approved by the department:

For the industry course an industry trained faculty member nominated by the Head of the department shall conduct a course during the semester. At the end of the semester an internal test shall be conducted. A student is required to score 40 marks out of 100 marks.

The B.Tech degree shall only be awarded if a student gets satisfactory grade (CS-Completed Successfully) in each of the mandatory audit/non credit courses besides acquiring 160 (120 for lateral entry) credits.

5. ATTENDANCE REQUIREMENTS:

5.1 A student shall be eligible to appear for semester end examinations if he/she acquires a minimum of 75% of attendance in aggregate of all the subjects in a semester.
5.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.
5.3 Shortage of Attendance below 65% in aggregate shall in NO CASE be condoned.
5.4 A stipulated fee shall be payable towards condonation of shortage of attendance to the College.
5.5 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examinations of that semester and their registration shall stand cancelled.
5.6 A student will not be promoted to the next semester unless he/she satisfies the attendance requirements of the present semester. They may seek readmission for that semester when offered next.

6. MINIMUM ACADEMIC REQUIREMENTS

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned under rule 5.0.

6.1 A Student is deemed to have satisfied the minimum academic requirements if he has earned the credits allotted to each theory/laboratory, design/drawing subject/project by securing not less than 35% of marks in the end semester exam, and minimum 40% of marks in the sum total of the internal marks and end semester examination marks.

6.2 A student shall register and put in minimum attendance in all 160 credits and earn all 160 credits.

7. PROGRAMME PATTERN

7.1 The entire programme of study is for four academic years, all the years are on semester pattern.
7.2 A student eligible to appear for the end semester examination in a subject, but absent or failed in the end semester examination, may write the examination in that subject when conducted next.
7.3 When a student is detained due to lack of credits / shortage of attendance, he may be re-admitted into the same semester / year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

8. PROMOTION TO NEXT HIGHER CLASS

8.1 A Student shall be promoted from 1st year to II year if he fulfills the minimum attendance requirement under rule 5.
8.2 A Student shall be promoted from II year to III year, if he fulfills the academic requirement of 50% of the credits up to II year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.
8.3 A student shall be promoted from III year to IV year if he fulfills the academic requirements of 50% of the credits up to III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

9. CUMULATIVE GRADE POINT AVERAGE (CGPA)

Theory/Laboratory Design/Drawing/Project work/mini project/socially relevant activity (%)	Letter Grade	Level	Grade Point
≥ 90	O	Outstanding	10
≥ 80 to < 90	S	Excellent	9
≥ 70 to < 80	A	Very Good	8
≥ 60 to < 70	B	Good	7
≥ 50 to < 60	C	Fair	6
≥ 40 to < 50	D	Satisfactory	5
<40	F	Fail	0
--	--	Absent	0

Computation of Semester Grade Point Average (SGPA)

The following procedure is to be adapted to compute the Semester Grade Point Average. (SGPA) and Cumulative Grade Point Average (CGPA).

The **SGPA** is the ratio of sum of product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student i.e.

$$\textbf{SGPA (Si)} = \sum(\text{Ci x Gi}) / \sum \text{Ci}$$

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

Computation of CGPA

- The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a programme i.e.,

$$\textbf{CGPA} = \sum(\text{Ci x Si}) / \sum \text{Ci}$$

- Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- Equivalent Percentage = (CGPA – 0.75) x 10

10. AWARD OF CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B.Tech Degree, he shall be placed in one of the following four classes.

Class Awarded	CGPA to be secured	
First Class with Distinction	≥ 7.75	**From the CGPA secured from 160 credits**
First Class	≥ 6.75 to < 7.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

11. MINIMUM INSTRUCTIONS DAYS.

The minimum instruction days for each semester shall be 90 working days

12. STUDENT TRANSFERS

12.1 There shall be no branch transfers after the completion of the admission process.

12.2 Pragati Engineering College (Autonomous) follows the practice of JNTUK/ State Government guidelines for transfer of students.

13. TRANSITORY REGULATIONS

13.1 Discontinued or Detained Students are eligible for readmission as and when next offered. The readmitted students will be governed by the regulations under which the student has been admitted.

13.2 a) In case of transferred students from other universities/colleges, the credits shall be transferred to Pragati Engineering College (Autonomous) R19 Academic Regulations and course structure of the respective discipline.

b) The students seeking transfer to Pragati Engineering College (Autonomous) from other universities/institutions have to obtain the credits of equivalent courses as prescribed by the college. In addition, the transferred students have to pass the courses in which they failed at the earlier institute.

14. GENERAL:

14.1 Whenever the words “he”, “him”, “his” secure in the regulations, they include “she”, “her”, “hers”.

14.2 The academic rules and regulations should be read as a whole for the purpose of interpretation.

14.3 In case of any doubt or ambiguity in the interpretation of rules, the decision of the principal of the college is final.

14.4 The college may change or amend the academic rules and regulations or syllabi at any time and the changed rules come into effect from the date of issue of such orders.

ACADEMIC REGULATIONS FOR B.TECH LATERAL ENTRY SCHEME (LES)

Applicable for the students admitted into II year B.Tech I semester from the Academic year 2020-21.

1. AWARD OF B.TECH DEGREE

A Student will be declared eligible for the award of B.Tech Degree if he fulfills the following academic regulations.

1.1. A Student shall be declared eligible for the award of the B.Tech Degree, if he pursues a course of study for not less than three academic years and not more than six academic years.

1.2 The candidate shall register for 120 credits and secure all the 120 credits.

2. The attendance regulations of B.Tech (Regular) shall be applicable to B.Tech (LES) students as well.

3. PROMOTION RULES

3.1 A student shall be promoted from III year to IV year if he fulfills the academic requirements of 50% of the credits up to III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. AWARD OF CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B.Tech Degree, he shall be placed in one of the following four classes.

Class Awarded	CGPA to be secured	
First Class with Distinction	≥ 7.75	**From the CGPA secured from 120 credits**
First Class	≥ 6.75 to < 7.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

5. All the other regulations as applicable to B.Tech 4-year degree course (Regular) will hold good for B.Tech (Lateral Entry Scheme) also.

MALPRACTIES RULES

MALPRACTIES RULES

DISCIPLINARY ACTION FOR MALPRACTICE/ IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled.
3	Impersonates any other candidate in connection with the examination	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to examiner requesting him to award pass marks	Cancellation of the performance in that subject.
6	Refuses to obey the orders of the Chief Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case will be registered against them.
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that

		semester/year. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8	Student of the college: Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10	Comes in a drunken condition to the examination Hall	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Principal for further action to award suitable punishment	

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

⇨ Ragging within or outside any educational institution is prohibited.

⇨ Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

LET US MAKE PRAGATI RAGGING FREE COLLEGE

ABSOLUTELY NO TO RAGGING

1. **Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.**
2. **Ragging entails heavy fines and/or imprisonment.**
3. **Ragging invokes suspension and dismissal from the College.**
4. **Outsiders are prohibited from entering the College and Hostel without permission.**
5. **Girl students must be in their hostel rooms by 7.00 p.m.**
6. **All the students must carry their Identity Cards and show them when demanded**
7. **The Principal and the Wardens may visit the Hostels and inspect the rooms any time.**

LET US MAKE PRAGATI RAGGING FREE COLLEGE

VISION AND MISSION OF THE COLLEGE

VISION

To Emerge as a Premier Institution for Technical Education in the Country through Academic Excellence and to be Recognized as a Centre for Excellence in Research & Development, Catering to the needs of our Country.

MISSION

To realize a strong Institution by consistently maintaining State-of-art-Infrastructure and building a cohesive, World Class Team and provide need based Technical Education, Research and Development through enhanced Industry Interaction.

VISION AND MISSION OF THE DEPARTMENT

VISSION:

To be a globally renowned school of mechanical engineering in transforming individuals into professional engineers with world class competency and state-of-the-art research to fulfil the technological needs of the society.

MISSION:

The department of mechanical engineering strives.
M1: To prepare, educate and guide students by the faculty from all domains of mechanical engineering in enhancing their skills.
M2: To establish and utilize world class resources and infrastructure to impart quality education and promote Research aptitude among faculty and students to pursue higher education in diverse fields.
M3: To explore the students' knowledge gradually through industrial interaction for increasing their placement potential to fulfil the basic needs of the society with ethical and social responsibility.

PROGRAM EDUCATIONAL OBJECTIVES

PEO-1: Apply technical knowledge in the domain of core engineering and allied disciplines contributing to society through interdisciplinary expertise.

PEO-2: Strengthen technical competence by enhancing their self-learning capacity throughout their professional career as well as to pursue higher education.

PEO-3: Explore their artistry in emerging areas of engineering flourishing their leadership qualities pertaining to ethical innovation with social responsibility.

PROGRAM OUTCOMES (POs)

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

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

PSO-1	To solve engineering problems through delineation and perusal relating to mechanical systems and other allied engineering streams with / without advanced software tools.
PSO-2	To work solitary / array in developing core and multidisciplinary concepts for effective utilization of resources ensuring the best practices in the relevant.

Bloom's Taxonomy Knowledge Level	**Knowledge Level Representation**
Remember	K1
Understand	K2
Apply	K3
Analyze	K4
Evaluate	K5
Create	K6

Mapping/correlation levels
1: Low
2: Medium
3. High

COURSE STRUCTURE

Zero Semester

Induction program (mandatory)	**3 weeks duration**
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch and Innovations

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days. We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.2 The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

I Year – I Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Humanities, Social Sciences including Management	19HE1T01	Professional Communicative English	3	--	--	3
2	Basic Sciences	19BM1T01	Linear Algebra and Differential Equations	3	--	--	3
3	Basic Sciences	19BC1T01	Engineering Chemistry	3	--	--	3
4	Engineering Sciences	19CS1T01	Programming for Problem Solving using C	3	--	--	3
5	Engineering Sciences	19ME1T01	Engineering Drawing	1	--	3	2.5
6	Basic Sciences	19BC1L01	Engineering Chemistry Laboratory	--	--	3	1.5
7	Humanities, Social Sciences including Management	19HE1L01	Professional Communicative English Laboratory-I	--	--	3	1.5
8	Engineering Sciences	19CS1L01	Programming for Problem Solving using C Laboratory	--	--	3	1.5
9	Mandatory Courses	19BE1T01	Environmental Science	2	--	--	0
Total Credits							**19**

I Year – II Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Basic Sciences	19BM2T02	Numerical Methods and Multi Variable Calculus	3	--	--	3
2	Basic Sciences	19BM2T03	Integral Transforms and Vector Calculus	3	--	--	3
3	Engineering Sciences	19ME2T02	Engineering Mechanics	3	--	--	3
4	Basic Sciences	19BP2T01	Engineering Physics	3	--	--	3
5	Engineering Sciences	19EE2T02	Basic Electrical and Electronics Engineering	3	--	--	3
6	Professional Core	19ME3T04	Materials Science and Metallurgy	3	--	--	3
7	Basic Sciences	19BP2L01	Engineering Physics Laboratory	--	--	3	1.5
8	Engineering Sciences	19ME2L02	Engineering Workshop	--	--	3	1.5
9	Mandatory Course	19HM2T05	Constitution of India	2	--	--	0
Total Credits							**21**

II Year – I Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Basic Sciences	19BM3T05	Complex Variables and Statistical Methods	3	--	--	3
2	Professional Core	19ME3T05	Mechanics of Solids	3	--	--	3
3	Professional Core	19ME3T06	Thermodynamics	3	--	--	3
4	Professional Core	19ME3T07	Fluid Mechanics and Hydraulic Machinery	3	--	--	3
5	Professional Core	19ME3T08	Production Technology	3	--	--	3
6	Lab Course	19ME2L03	Computer Aided Engineering Drawing Practice	--	--	3	1.5
7	Engineering Sciences	19EE3L02	Basic Electrical and Electronics Engineering Laboratory	--	--	3	1.5
8	Lab Course	19ME3L05	Metallurgy and Mechanics of Solids Laboratory	--	--	3	1.5
9	Project Work	19ME3P01	Socially Relevant Activity*	--	--	--	0.5
10	Mandatory Course	19HM3T07	Professional Ethics and Human Values	2	--	--	0
Total Credits							**20**

***15hrs per semester**

II Year – II Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Professional Core	19ME4T09	Kinematics of Machinery	3	--	--	3
2	Professional Core	19ME4T10	Applied Thermodynamics	3	--	--	3
3	Humanities, Social Sciences including Management	19HM4T01	Managerial Economics and Financial Analysis	3	--	--	3
4	Professional Core	19ME4T11	Design of Machine Members-I	3	--	--	3
5	Professional Core	19ME4T12	Metal Cutting and Machine Tools	3	--	--	3
6	Professional Core	19ME4T13	Machine Drawing	1	--	4	3
7	Lab Course	19ME4L06	Fluid Mechanics and Hydraulic Machinery Laboratory	--	--	3	1.5
8	Lab Course	19ME4L07	Production Technology Laboratory	--	--	3	1.5
9	Mandatory Course	19HM4T06	Essence of Indian Traditional Knowledge	2	--	--	0
Total Credits							**21**

III Year – I Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Professional Core	19ME5T14	Dynamics of Machinery	3	--	--	3
2	Professional Core	19ME5T15	Design of Machine Members-II	3	--	--	3
3	Professional Core	19ME5T16	Operations Research	3	--	--	3
4	Professional Core	19ME5T17	IC Engines and Turbo Machinery	3	--	--	3
5	Professional Elective		**Professional Elective-I**	3	--	--	3
6	Open Elective		**Open Elective-I**	3	--	--	3
7	Lab Course	19ME5L08	Machine Tools and Theory of Machines Laboratory	--	--	3	1.5
8	Lab Course	19ME5L09	Thermal Engineering Laboratory	--	--	3	1.5
9	Mandatory Course	19ME5T49	MOOCS/Industry Courses approved by Department**	--	--	--	0
Total Credits							**21**

****Student can select the course of any discipline under MOOCS. However the agency will be decided by the respective BOS

List of Approved MOOC providers

CSWAYAM	Iversity	Coursera	Udemy	EduKart

III Year – II Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Professional Core	19ME6T22	Industrial Engineering and Management	3	--	--	3
2	Professional Core	19ME6T23	Instrumentation and Control Systems	3	--	--	3
3	Professional Core	19ME6T24	Metrology	3	--	--	3
4	Professional Core	19ME6T25	Heat Transfer	3	--	--	3
5	Professional Elective		**Professional Elective-II**	3	--	--	3
6	Open Elective		**Open Elective-II**	3	--	--	3
7	Lab Course	19ME6L10	Heat Transfer Laboratory	--	--	3	1.5
8	Lab Course	19ME6L11	Metrology & Instrumentation Laboratory	--	--	3	1.5
9	Project Work	19ME6P02	Mini Project	--	--	2	1
10	Mandatory Course	19HM6T08	IPR & Patents	2	--	--	0
Total Credits							**22**

IV Year – I Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Professional Core	19ME7T30	CAD/CAM	3	--	--	3
2	Professional Core	19ME7T31	Finite Element Methods	3	--	--	3
3	Professional Elective		**Professional Elective III**	3	--	--	3
4	Professional Elective		**Professional Elective IV**	3	--	--	3
5	Open Elective		**Open Elective-III**	3	--	--	3
6	Lab Course	19ME7L12	CAD/CFD Laboratory	--	--	3	1.5
7	Lab Course	19ME7L13	CAM/Mechatronics Laboratory	--	--	3	1.5
Total Credits							**18**

IV Year – II Semester

S. No.	Course Category	Course Code	Course Title	L	T	P	C
1	Professional Core	19ME8T40	Unconventional Machining Processes	3	--	--	3
2	Professional Elective		**Professional Elective-V**	3	--	--	3
3	Professional Elective		**Professional Elective-VI**	3	--	--	3
4	Project Work	19ME8P03	Project Work	--	--	18	9
Total Credits							**18**
Total Credits (19 + 21 + 20 + 21 + 21+ 22 + 18 + 18)							**160**

L- Lecture **T- Tutorial** **P-Practical** **C-Credits**

Professional Elective-I

S. No.	Course Code	Title of the Course
1	19ME5T18	Automobile Engineering
2	19ME5T19	Nano Technology
3	19ME5T20	Automation in Manufacturing
4	19ME5T21	Total Quality Management

Professional Elective-II

S. No.	Course Code	Title of the Course
1	19ME6T26	Power Plant Engineering
2	19ME6T27	Mechatronics
3	19ME6T28	Industrial Robotics
4	19ME6T29	Supply Chain Management

Professional Elective III

S. No.	Course Code	Title of the Course
1	19ME7T32	Refrigeration & Air-conditioning
2	19ME7T33	MEMS
3	19ME7T34	Additive Manufacturing
4	19ME7T35	Optimization Techniques

Professional Elective IV

S. No.	Course Code	Title of the Course
1	19ME7T36	Gas Dynamics & Jet Propulsion
2	19ME7T37	Mechanical Vibrations
3	19ME7T38	Design for Manufacturing
4	19ME7T39	Management of Inventory Systems

Professional Elective V

S. No.	Course Code	Title of the Course
1	19ME8T41	Computational Fluid Dynamics
2	19ME8T42	Mechanical Behavior of Materials
3	19ME8T43	Joining Processes
4	19ME8T44	Production Planning and Control

Professional Elective VI

S. No.	Course Code	Title of the Course
1	19ME8T45	Thermal Equipment Design
2	19ME8T46	Advanced Mechanics of Solids
3	19ME8T47	Non-Destructive Evaluation
4	19ME8T48	Facilities Layout and Design

Open Elective I

S. No.	Course Code	Title of the Course
1	19CE5T18	Environmental Impact Assessment & Management
2	19EE5T24	Energy Audit, Conservation and Management
3	19EC5T10	Internet of Things
4	19CS5T05	Object Oriented Programming through Java
5	19HM5T03	Entrepreneurship

Open Elective II

S. No.	Course Code	Title of the Course
1	19CE6T23	Building Materials and Construction
2	19EE6T36	Power Safety and Management
3	19EC6T20	Microprocessors and Microcontrollers
4	19CS6T17	Computer Graphics
5	19HE6T02	Soft Skills and Interpersonal Communication

Open Elective III

S. No.	Course Code	Title of the Course
1	19CE7T38	Remote Sensing and GIS Applications
2	19EE7T12	Power Electronics
3	19EC7T39	Electronic Measurement and Instruments
4	19CS7T03	Python Programming
5	19HM7T04	Marketing Management

I Year I Semester
Professional Communicative English
(Common to CE, EEE, MECH, ECE, CSE & IT)

Course Category	Basic Sciences	**Course Code**	19HE1T01
Course Type	Theory	**L-T-P-C**	3 – 0 – 0 – 3
Prerequisites	LSRW + Vocabulary Synonyms, antonyms, Grammar.	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Schumacher describes the education system by saying that it was mere training, something more than mere knowledge of facts. To develop extensive reading skill and comprehension for pleasure and profit.
2	The lesson centers on the pros and cons of the development of science and technology. To develop extensive reading skill and comprehension for pleasure and profit.
3	Depicts of the symptoms of Cultural Shock and the aftermath consequences. To develop extensive reading skill and comprehension for pleasure and profit.
4	Portrays the ways of living life in its true sense. To develop extensive reading skill and comprehension for pleasure and profit.
5	Supports the developments of technology for the betterment of human life. To develop extensive reading skill and comprehension for pleasure and profit.
COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	
CO1	Emphasizes that the ultimate aim of education is to enhance wisdom and inspires the readers to serve their nation with their self-enrichment.
CO2	Enables the learners to promote peaceful co-existence and universal harmony in the society and empowers the learners to have initiation in innovation.
CO3	Imparts the students to manage different cultural shock due to globalization and to develop multiculturalism to appreciate diverse cultures and also motivates the learners to contribute to their nation.
CO4	Arouse the thought of life to lead in a well path by recognizing the importance of work besides enhancing their LSRW skills.
CO5	Inspires the learners at the advancement of software by the eminent personalities and motivates the readers to think and tap their innate talents.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	-	-	-	-	2	1	-	-	1	-	3	-	-
CO2	2	1	-	-	-	1	3	1	-	1	-	1	-	-
CO3	-	-	-	-	-	1	2	-	-	1	-	-	-	-
CO4	-	-	-	-	-	1	-	1	2	-	-	-	-	-
CO5	-	-	1	2	1	-	-	-	-	1	-	-	-	-

COURSE CONTENT

UNIT I

1. The Greatest Resource- Education' from Professional Communicative English.
2. 'War' from ‘Panorama: A Course on Reading'

UNIT II

1. ' A Dilemma' from Professional Communicative English.

'The Verger' from ‘Panorama: A Course on Reading'

UNIT III

1. 'Cultural Shock': Adjustments to new Cultural Environments from Professional Communicative English.
2. The Scarecrow' from Panorama: A Course on Reading

UNIT IV

1. ‘The Secret of Work’ from Professional Communicative English.
2. 'A Village Lost to the Nation' from Panorama: A Course on Reading

UNIT V

1. ' The Chief Software Architect' from Professional Communicative English.
2. 'Martin Luther King and Africa' from Panorama: A Course on Reading

TEXT BOOKS

1. PROFESSIONAL COMMUNICATIVE ENGLISH.Published by Maruthi Publishers.
2. PANORAMA: A COURSE ON READING, Published by Oxford University Press India

REFERENCE BOOKS

1. ENGLISH GRAMMAR AND COMPOSITION – WREN & MARTIN
2. LEARNER’S ENGLISH GRAMMAR AND COMPOSITION – N.D.V. Prasada Rao

WEB RESOURCES

Online Dictionaries:

https://dictionary.cambridge.org/
https://www.oxfordlearnersdictionaries.com/

Grammar:

https://www.oxfordlearnersdictionaries.com/grammar/
https://dictionary.cambridge.org/grammar/british-grammar/

Synonyms and Antonyms:

https://www.thesaurus.com/browse/search
https://www.englishclub.com/vocabulary/synonyms-antonyms.htm

I Year I Semester
Linear Algebra and Differential Equations
(Common to CE, EEE, ME, ECE, CSE & IT)

Course Category	Basic Sciences	**Course Code**	19BM1T01
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Basics of matrices, Differentiation, Integration	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2	The skills derived from the course will help the student form a necessary base to develop analytic and design concepts.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Solve systems of linear equations, determine the rank, find the eigen values and eigenvectors, diagonalization of a matrix.	K3
CO2	Identify special properties of a matrix, such as positive definite, etc., and use this information to facilitate the calculation of matrix characteristics.	K2
CO3	Solve first order differential equations and its applications	K3
CO4	Solve the linear differential equations with constant coefficients by appropriate method	K3
CO5	Find partial derivatives of multivariable functions and apply them to find extreme values of a function.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I
Solving system of linear equations, Eigen Values and Eigen vectors
Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous linear equations – Gauss elimination method for solving system of equations – Eigenvalues and Eigen vectors and their properties.

UNIT II
Cayley-Hamilton Theorem and Quadratic forms
Cayley-Hamilton theorem (without proof) – Finding inverse and powers of a matrix by Cayley-Hamilton theorem – Reduction to diagonal form-Quadratic forms-nature of the quadratic form - reduction of quadratic form to canonical form by orthogonal transformation.

UNIT III

Differential equations of first order and first degree

Linear – Bernoulli – Exact – Reducible to exact.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories.

UNIT IV

Linear differential equations of higher order

Non-homogeneous equations of higher order with constant coefficients with RHS term of the type e^{ax}, $\sin ax$, $\cos ax$, polynomials in x^n, $e^{ax}V(x)$, $x^mV(x)$ - Method of Variation of parameters.

UNIT V

Partial differentiation

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Generalized Mean value theorem for single variable (without proof) – Taylor's and Maclaurin's series expansion of functions of two variables – Jacobian – Functional dependence.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

TEXT BOOKS

1. **B.S.Grewal**, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India

REFERENCE BOOKS

1. **Micheael Greenberg**, Advanced Engineering Mathematics, 9th edition, Pearson edn
2. **Dean G. Duffy**, Advanced engineering mathematics with MATLAB, CRC Press.
3. **Peter O'neil**, Advanced Engineering Mathematics, Cengage Learning.
4. **Srimanta Pal, Subodh C.Bhunia**, Engineering Mathematics, Oxford University Press.
5. **T.K.V. Iyengar et. al.,** Engineering Mathematics Volume I & III S Chand Publications.

WEB RESOURCES

UNIT I: Solving system of linear equations, Eigen Values and Eigen vectors

https://en.wikipedia.org/wiki/System_of_linear_equations

https://en.wikipedia.org/wiki/Eigenvalues_and_eigenvectors

UNIT II: Cayley-Hamilton Theorem and Quadratic forms

https://www.math.hmc.edu/calculus/tutorials/eigenstuff/

https://en.wikipedia.org/wiki/Quadratic_form

UNIT III: Differential equations of first order and first degree

https://en.wikipedia.org/wiki/Differential_equation

http://um.mendelu.cz/maw-html/index.php?lang=en&form=ode

https://www.khanacademy.org/math/differential-equations/first-order-differential-equations

UNIT IV: Linear differential equations of higher order

https://en.wikipedia.org/wiki/Differential_equation

http://um.mendelu.cz/maw-html/index.php?lang=en&form=ode

https://nptel.ac.in/courses/122107037/20

UNIT V: Partial Differentiation

https://en.wikipedia.org/wiki/Partial_derivative

https://www.whitman.edu/mathematics/calculus_online/section14.03.html

I Year I Semester
ENGINEERING CHEMISTRY
(Mechanical Engineering)

Course Category	Basic Sciences	**Course Code**	19BC1T01
Course Type	Theory	**L-T-P-C**	3-0-3-3
Prerequisites	Intermediate Chemistry	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn about the hardness of water, boiler troubles, Drinking water standards and methods of removal of hardness of water
2	To get knowledge on Electrochemical cells, Batteries and fuel cells and their applications
3	To study about the factors affecting corrosion, controlling methods and about organic coatings
4	To learn about Cement, its setting and hardness, methods of polymerization, Plastics and Elastomers
5	To study about Nano materials, their preparation and applications and to gain awareness on smart materials,

COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	
CO1	Distinguish between temporary and permanent hardness of water.
CO2	Illustrate the principles and applications of Batteries and Fuel cells
CO3	Identify different types of corrosion and their controlling methods.
CO4	Illustrate the principles of setting and hardening of cement and explain about polymers and their engineering applications.
CO5	Analyze the importance of nano and smart materials and Illustrate the principle of BET & TEM.

Contribution of Course Outcomes towards achievement of Program :
Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	2	1	2	-	3	3	-	-	-	3	1	1	-
CO2	2	1	-	-	2	-	1	-	-	-	2	2	-	-
CO3	1	-	2	-	2	-	1	-	-	-	1	-	-	1
CO4	3	-	1	2	-	1	1	-	-	-	2	-	1	-
CO5	2	-	3	-	-	2	2	-	-	-	1	1	-	1

COURSE CONTENT

UNIT I

WATER TECHNOLOGY

Introduction –Hard and Soft water, Estimation of hardness by EDTA Method - Boiler troubles - scale and sludge-priming and foaming and Caustic Embrittlement; Specifications for drinking water, Bureau of Indian Standards (BIS) and World health organization (WHO) standards, Industrial water – Primary and secondary treatments, zeolite and ion-exchange processes- desalination of brackish water, reverse osmosis (RO) and electro dialysis.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- **Explain** the principles of reverse osmosis and electro dialysis. (**L-2)**
- **Compare** the quality of drinking water with BIS and WHO standards. (**L-2)**
- **Illustrate** boiler troubles associated with hard water. (**L-2)**
- **Demonstrate** the Industrial water treatment processes. (**L-2)**

UNIT II

ENERGY SOURCES AND APPLICATIONS

Electrode potential, determination of single electrode potential –Nernst's equation, Reference electrodes: Hydrogen and calomel electrodes – electrochemical series and its applications

Batteries: Primary cell- dry or Leclanche cell, Secondary cell- Nickel-Cadmium cell – lithium batteries (Lithium-MnO_2); Fuel cells- H_2-O_2 fuel cell

Solar energy: Photovoltaic cell and its applications.

Fuels- Classification and characteristics-Liquid fuels- Refining of petroleum; gaseous fuels-LPG and CNG applications

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **Define** electrode potential. (**L-1)**
- **Derive** Nernst's equation. (**L-2)**
- **Outline** the difference between primary and secondary cells. (**L-2)**
- **Identify** the applications of photo voltaic cell. (**L-2)**
- **Discuss** the applications of LPG and CNG (**L-2**)

UNIT III

CORROSION ENGINEERING

III-A: Corrosion: Definition – theories of corrosion-Dry corrosion: Metal oxide formation - pilling bed worth ratio; Electro chemical corrosion: Mechanism, Factors affecting corrosion (nature of the metal and nature of the environment).

III-B: Corrosion controlling methods: Sacrificial and Impressed current cathodic protection.

Metallic coatings – Galvanizing and Tinning- Electro plating and Electro less plating; Anodic inhibitors and Cathodic inhibitors.

Organic coatings – Paints and Varnishes (constituents and their functions).

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **Explain** theories of corrosion. (**L-2)**
- **Identify** the various factors affecting corrosion. (**L-3)**
- **classify** different inhibitors of corrosion (**L-2**)
- **Choose** different organic coatings. (**L-3)**
- **Apply** the principles of corrosion control. **(L-3)**

UNIT IV

ENGINEERING MATERIALS AND POLYMERS

Cement: Portland cement, constituents, Manufacture of Portland Cement, Chemistry of setting and hardening of Cement (hydration, hydrolysis, equations).

Refectories-Classification, properties(refractoriness, refractoriness under load, porosity)

Polymers: Introduction-Methods of Polymerization (Emulsion and Suspension), Conducting polymers – Mechanism of conduction in poly acetylene – applications, Bio – degradable polymers.

Plastics: Thermoplastics and thermo setting resins; Moulding of plastics – Compression and Injection moulding - Preparation, properties and applications of Polystyrene and Bakelite.

Elastomers: Natural Rubber, Vulcanization of rubber; Synthetic Rubbers -Preparation, properties and applications of Buna-S and Thiokol.

Learning outcomes:

After the completion of the Unit IV, the student will be able to

- **Illustrate** the chemical reactions involved in the manufacturing of cement and properties of refractories. (**L-2)**
- **Identify** preparation and properties of different polymers. **(L-3)**
- **Distinguish** between thermoplastic and thermo setting resins. (**L-4)**

- **Identify** applications of conducting polymers **(L-3)**

UNIT V

NANO AND SMART MATERIALS

Nano Materials: Introduction to Nano materials, Preparation of Carbon Nano Tubes(CNTs) by Laser Ablation and Chemical Vapor Deposition Methods, Fullerenes -Preparation, Properties and Applications; Chemical synthesis of nano materials : Sol-gel method, Characterization of nano mateirals by BET & TEM (basic principles), Applications of nano materials in waste water treatment, lubricants, Medicine and sensors.

Smart Materials: Introduction – Types of smart materials-Self healing materials, Shape memory alloys and uses of smart materials.

Learning outcomes:

After the completion of the Unit V, the student will be able to

- **Classify** nano materials. (**L-2)**
- **Explain** the synthesis and characterization methods of nano materials. (**L-2)**
- **Explain** principles of BET & TEM. **(L-4)**
- **Identify** different types of smart materials. (**L-2)**

TEXT BOOKS

1. P.C. Jain and M. Jain, Engineering Chemistry, 15/e, Dhanapat Rai & Sons, Delhi (2014).
2. Engineering Chemistry by Shikha Agarwal: Cambridge University Press,2019 edition .

REFERENCE BOOKS

1. Sashi Chawla, A Textbook of Engineering Chemistry, Dhanapath Rai and sons, (2003)
2. S.S. Dara, A Textbook of Engineering Chemistry, S.Chand & Co, (2010)
3. N. Krishna Murthy and Anuradha, A text book of Engineering Chemistry, Murthy Publications (2014)

WEB RESOURCES

Unit I Water Technology

1.https://www.scribd.com/document/.../Engineering-Chemistry-Unit-I-Water-Treatment
2.www.lenntech.com/applications/process/boiler/boiler-water-treatment.htm

Unit II Energy Sources and Applications

https://en.wikipedia.org/wiki/Electrochemical_cell

Unit III Corrosion Engineering &Corrosion controlling methods

https://en.wikipedia.org/wiki/Corrosion

Unit IV Engineering Materials and Polymers

https://en.wikipedia.org/wiki/Polymer_chemistry

Unit V Nano and Smart Materials

https://en.wikipedia.org/wiki/Nanomaterials

I Year I Semester
Programming for Problem solving using C
(Common to CE, ME, EEE, ECE, CSE, IT)

Course Category	Engineering Science	**Course Code**	19CS1T01
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To impart adequate knowledge on the need of programming languages and problem solving techniques.
2	To develop programming skills using the fundamentals of C Language.
3	To enable effective usage of arrays, structures, functions, pointers and dynamic memory allocation.
4	To make use of file handling functions in programming.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Apply the fundamentals of C Programming for Problem solving.	K3
CO2	Identify the appropriate Decision statement and Loops for a given Problem.	K2
CO3	Make use of Arrays and Strings to solve the problems in C.	K3
CO4	Apply the concepts of Functions and Pointers in Problem solving.	K3
CO5	Develop solutions for problems using Structures, Unions and Files.	K3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	1	-	-	-	-	-	-	-	1	1
CO2	3	3	3	3	1	-	-	-	-	-	-	-	1	1
CO3	3	3	3	2	1	-	-	-	-	-	-	-	2	1
CO4	2	3	3	3	1	-	-	-	-	-	-	-	2	2
CO5	3	3	3	3	1	-	-	-	-	-	-	-	2	2

COURSE CONTENT

UNIT I

Introduction to Programming–Introduction to Computer Software, Classification of Computer Software, Representation of Data – Bits and Bytes, Programming Languages –High and Low Level Languages, Generation of Programming Languages, Program Design Tools: Algorithms, Flowcharts, Pseudocode, Types of Errors, Testing & Debugging Approaches.

Introduction to C – Structure of a C Program, Writing the First C Program, Header Files used in C Program, Compiling and Executing C Programs.

UNIT II

Tokens in C: Basic Data Types in C – Keywords, Identifiers, Variables, Constants, Input / Output statements in C, Operators in C, Precedence and Associativity Rules, Type Casting Types.

Decision Control: Decision Control Statements: Conditional Branching Statements - if, if – else, nested if, if – else – if, and Switch – Case.

Basic Loop Structures: Iterative Statements - for, while and do - while, Nested Loops, The 'Break', 'Continue', and 'goto' statements.

UNIT III

Arrays: Declaration and Initialization of Arrays, Accessing & Storing the elements of an Array, Operations on Arrays: Traversing, Inserting, Deleting, Searching, Two Dimensional Arrays: Declaring, Initializing, Accessing, Operations on Two Dimensional Arrays (Matrices), Applications of Arrays.

Strings: String Fundamentals, String Input and Output, String Library Functions.

UNIT IV

Functions: Function Declaration / Function Prototypes, Function Definition, Function Call (Call by Value), Passing Parameters to Functions, Return Statement, Storage Classes, Recursive Functions, Arrays as Function Arguments.

Pointers: Declaring Pointer Variables, Pointer Arithmetic, Passing Arguments to Function using Pointers (Call by Reference), Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation – Malloc, Calloc, Realloc, Free.

UNIT V

Structures: Introduction to Structures, Nested Structures, Array of Structures.

Unions: Introduction, Array of Union Variables, Union inside Structure, Enumerated Data Types, Bit Fields.

Files: Declaring, Opening, and Closing File, Reading from and Writing to Text Files.

TEXT BOOKS

1. Programming in C, Reema Thareja, 2nd Edition, Oxford University Press.
2. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.

REFERENCE BOOKS

1. Programming in C – Ashok N.Kamthane, Amit Ashok Kamthane, 3rd Edition, Pearson.
2. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
3. Programming in C (A Practical Approach) – Ajay Mittal, First Edition, Pearson.

WEB RESOURCES

http://nptel.ac.in/courses/106104128/
http://students.iitk.ac.in/programmingclub/course/#notes
http://c-faq.com/~scs/cclass/cclass.html
http://www.youtube.com/watch?v=b00HsZvg-V0&feature=relmfu
http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-087-practical-programming-in-c-january-iap-2010/

I Year I Semester
ENGINEERING DRAWING

Course Category	Engineering Science	**Course Code**	19ME1T01
Course Type	Theory	**L-T-P-C**	1-0-3-2.5
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To introduce the students to use drawing instruments and to draw polygons, Engineering Curves and Scales.
2	To introduce the students to use orthographic projections, projections of points and lines.
3	To make the students draw the projections of the planes.
4	To make the students draw the projections of the various types of solids.
5	To represent the object in 3D view through isometric views.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Construct polygons, scales and engineering curves.	K3
CO2	Identify the position of points and lines with use of orthographic projections.	K3
CO3	Analyze the location and position of plane figures through orthographic projections.	K4
CO4	Analyze the location and position of solid bodies through orthographic projections.	K4
CO5	Develop 2D and 3D objects by converting their views.	K6

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	1	-	-	-	-	-	1	-	1	-
CO2	3	2	1	2	1	-	-	-	-	-	1	-	1	-
CO3	3	2	1	2	1	-	-	-	-	-	1	-	1	-
CO4	3	2	1	2	1	-	-	-	-	-	1	-	1	-
CO5	3	2	1	3	3	-	-	-	-	-	1	-	1	-

COURSE CONTENT

UNIT I

Introduction to Engineering Drawing.

Polygons: Constructing regular polygons by general method.

Curves: Parabola, Ellipse and Hyperbola by general methods tangent & normal for the curves. Cycloid and Involutes.

Scales: Vernier and Diagonal scales.

UNIT II

Orthographic Projections: Introduction, importance of reference lines, projections of points in various quadrants. Projections of straight lines inclined to both the planes, determination of true lengths and angle of inclination.

UNIT III

Projections of planes: Regular planes perpendicular/parallel to one plane.

Regular planes inclined to one plane and parallel to other, inclined to both the planes.

UNIT IV

Projections of Solids: Simple positions of Prisms, Pyramids, Cones and Cylinders. Solids inclined to both the planes.

UNIT V

Isometric Projections: Introduction, Conversion of isometric views to orthographic views, Conversion of orthographic views to isometric views.

Introduction to AutoCAD (Demo only)

TEXT BOOKS

1. Engineering Drawing by N.D. Bhatt, Chariot Publications, 56th Edition.
2. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age International (P) Limited (2008).

REFERENCE BOOKS

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers, 3rd Edition.
2. Engineering Graphics for Degree by K.C. John, PHI Publishers.
3. Engineering Graphics by PI Varghese, Mc Graw Hill Publishers, 2013.
4. Engineering Drawing by Basant Agarwal, Tata McGraw Hill Publishers, 2014.
5. B.V.R. Gupta & M. Raja Roy, Engineering Drawing, I.K. International Publishing House Pvt. Ltd., 2009.

WEB RESOURCES

http://nptel.ac.in/courses/112103019/

http://www.me.umn.edu/courses/me2011/handouts/drawing/blanco-tutorial.html

https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/env_health_science_students/engineeringdrawing.pdf

I Year I Semester
Engineering Chemistry Laboratory

Course Category:	Basic sciences	**Course Code**	19BC1LC01
Course Type:	Lab	**L-T-P-C**	0 -0 -3-1.5
Prerequisites:	Basic Chemistry	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSEOUTCOMES

Upon successful completion of the course, the student will be able to:	
CO1	Students will learn to estimate the given amount of dissolved compounds in water by using volumetric analysis and preparation of polymers and nano particles
CO2	Students will be able to learn compelxometric titrations to determine the concentration of different metal ions present in water.
CO3	Students will be able to identify the accurate value of P^H and conductivity of given solutions. and to estimate the viscosity and surface tension of given solutions.

Contribution of Course Outcomes towards achievement of Program Outcomes (1–Low,2-Medium,3–High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2
CO1	2	1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-	-	-

COURSECONTENT

(Any 10 of the following listed 14 experiments)

LIST OF EXPERIMENTS:

Introduction to chemistry laboratory – Molarity, Normality, Primary, Secondary standard solutions, Volumetric titrations, Quantitative analysis

1. Estimation of HCI using standard Na_2CO_3 solutions
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH
3. Estimation of $KMnO_4$ using standard Oxalic acid solution.
4. Estimation of Ferrous iron using standard $K_2Cr_2O_7$ solution
5. Determination of Temporary and permanent Hardness water using standard EDTA solution.
6. Determination of pH of the given sample solution using pH meter
7. Determination of Iron (III) using Colorimetric method
8. Conductometric Titrations between strong acid and strong base
9. Conductometric Titrations between strong acid and weak base
10. Estimation of Vitamin – C
11. Preparation of Phenol - Formaldehyde Resin
12. Determination of viscosity of a liquid
13. Determination of surface tension of a liquid
14. Preparation of Nano particles.(Cu/Zn)

TEXTBOOKS

1. Mendham J, Denney RC, Barnes JD, Thosmas M and Sivasankar B Vogel's Quantitative Chemical Analysis 6/e, Pearson publishers (2000).
2. N.K Bhasin and Sudha Rani Laboratory Manual on Engineering Chemistry 3/e, Dhanpat Rai Publishing Company (2007).

REFERENCEBOOKS

Vogel's Textbook of Quantitative chemical analysis, J. Mendham et.al.
[1] College designed manual

WEB-RESOURCES

1. www.bsauniv.ac.in/UploadImages/Downloads/Estimation%20of%20Hardness
2. https://pubs.acs.org/doi/abs/10.1021/i560133a023
3. https://pdfs.semanticscholar.org/33d4/3b264bad212a14d660667298f12944ea11d5

I Year I Semester
Professional Communicative English Laboratory – I
(For CE, EEE, ME, CSE & IT)

Course Category	Basic Sciences	**Course Code**	19HE1L01
Course Type	Laboratory	**L-T-P-C**	0 – 0 – 3 – 1.5
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

PRESCRIBED LAB MANUAL FOR SEMESTER I:
STRENGTHEN YOUR STEPS: A Multimodal Course in Communication Skills' Published by Maruthi Publications.

COURSE OBJECTIVE
To enable the students to learn the communication skills; listening, speaking, reading and writing.
COURSE OUTCOME
The course enables the learner to acquire communication skills which will help the students to become successful in the competitive world.

COURSE CONTENT

The course content along with the study material is divided into six units.

UNIT 1:
Hello, I'm ……
Consonant Sounds

UNIT 2:
I would love to …. But,
Vowel Sounds

UNIT 3:
With your Permission, I would like to
Syllable and Accent

UNIT 4:
Why don't we……
Pronunciation and Rhythm

UNIT 5:
Could you please ……
Tones

UNIT-6: Dialogues

I year I semester
Programming for Problem solving using C Laboratory
(Common to CE, ME, EEE, ECE, CSE, IT)

Course Category	Engineering Science	**Course Code**	19C S1L01
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To learn various steps in program development using Raptor.
2	To write C programs using basic concepts in C like operators, control statements etc.,
3	To design modular, reusable and readable C programs using concepts like Arrays, Functions and Pointers.
4	To write programs using Structures and Unions.
5.	To write programs to perform file operations.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Translate given algorithms to working programs.	K2
CO2	Design programs using Pointers to access Arrays, Strings and Functions.	K3
CO3	Develop programs using Structures, Unions and File operations.	K3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	2	-	-	-	-	-	-	-	2	2
CO2	3	3	3	3	2	-	-	-	-	-	-	-	2	2
CO3	3	3	3	3	2	-	-	-	-	-	-	-	2	2

COURSE CONTENT	
1.	Construct flowcharts using Raptor Tool to a) calculate the maximum, minimum and average of three numbers b) calculate area of a triangle given three sides using Heron's formula.
2.	Construct flowcharts using Raptor Tool to a) calculate simple interest for various parameters specified by the user. b) swapping of two numbers with and without using the third variable.
3.	Write a C Program to Perform Addition, Subtraction, Multiplication and Division of two numbers.

<table>
<tr><td>4.</td><td>Write a C Program to find the Grade of a student by taking input of percentage using all Relational Operators (>, >=, <, <=, ==, !=)
<table>
<tr><th>Theory (%)</th><th>Letter Grade</th><th>Level</th></tr>
<tr><td>≥ 90</td><td>O</td><td>Outstanding</td></tr>
<tr><td>≥ 80 to < 90</td><td>S</td><td>Excellent</td></tr>
<tr><td>≥ 70 to < 80</td><td>A</td><td>Very Good</td></tr>
<tr><td>≥ 60 to < 70</td><td>B</td><td>Good</td></tr>
<tr><td>≥ 50 to < 60</td><td>C</td><td>Fair</td></tr>
<tr><td>≥ 40 to < 50</td><td>D</td><td>Satisfactory</td></tr>
<tr><td><40</td><td>F</td><td>Fail</td></tr>
</table></td></tr>
<tr><td>5.</td><td>Write a C Program to swap two given input numbers
a) With using a temporary variable. b) Without using a temporary variable.</td></tr>
<tr><td>6.</td><td>Write a C Program to implement arithmetic operations using two operands and one operator using
a) if – else – if condition. b) Switch – Case statement.</td></tr>
<tr><td>7.</td><td>Write a C Program to print the following patterns
a) Floyd’s Triangle. b) Pascal Triangle.</td></tr>
<tr><td>8.</td><td>Write a C Program
a) To find the sum of its individual digits for a given positive number.
b) To check whether the given number is Prime or not.</td></tr>
<tr><td>9.</td><td>Write a C Program
a) To check whether the given number is a Palindrome or not.
b) To check whether the given number is an Armstrong or not</td></tr>
<tr><td>10.</td><td>Write a C Program using Functions to find both the largest and smallest number in an given array numbers.</td></tr>
<tr><td>11.</td><td>Write C programs to perform swapping of two numbers by passing a value and reference.</td></tr>
<tr><td>12.</td><td>Write a C Program for two Matrices by checking the compatibility
a) Addition. b) Multiplication.</td></tr>
<tr><td>13.</td><td>Write a C program on Strings to implement the following operations without string handling functions
a) Concatenation of two given input strings. b)Length of a string.
c) Reverse of a given string.</td></tr>
<tr><td>14.</td><td>Write C programs that use both recursive and non-recursive functions for the following
i) To find the factorial of a given integer.
ii) To find the GCD (greatest common divisor) of two given integers.
iii) To find Fibonacci sequence</td></tr>
<tr><td>15.</td><td>Write a C program using Pointers to work on
a) Matrix Addition. b) Transpose of a Matrix.</td></tr>
<tr><td>16.</td><td>Write a C program to read and print the details of an Employee (Name, Date of the Birth, Designation, Salary) using Structures.</td></tr>
<tr><td>17.</td><td>Write a C program
a) to read and print the student details (Name, Register number, Address, Intermediate %) using Union.
b) to display the name of the colour using Enum data type</td></tr>
<tr><td>18.</td><td>Write a C Program to
a) Copy one file to another. b)Count the number of characters, words and lines in a file.</td></tr>
</table>

I Year I Semester
Environmental Science
(Common to All Branches)

Course Category	Basic Sciences	**Course Code**	19BE1T01
Course Type	Theory	**L-T-P-C**	3 – 0 – 0 – 0
Prerequisites	Exposure Basic Knowledge in Environment and protection.	**Total Marks(Internal Assessment)**	100

COURSE OBJECTIVE:	
1	To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Recognize the interconnectedness of human dependence on the earth's ecosystems	**K2**
CO2	Comprehend environmental problems from multiple perspectives with emphasis on human modern lifestyles and developmental activities	**K1**
CO3	Demonstrate knowledge relating to the biological systems involved in the major global environmental problems of the 21st century	**K2**
CO4	Gain a higher level of personal involvement and interest in understanding and solving environmental problems.	**K2**
CO5	Learn the management of environmental hazards and to mitigate disasters and have a clear understanding of environmental concerns and follow sustainable development practices	**K3**
CO6	Influence their society in proper utilization of goods and services.	**K1**

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	-	1	-	-	1	2	-	-	-	1	-	-	-
CO2	-	1	-	-	-	-	1	-	-	-	-	-	-	-
CO3	-	-	-	-	2	-	1	-	-	-	-	-	-	-
CO4	-	-	-	-	1	1	3	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	3	1	-	-	-	-	-	-

COURSE CONTENT

UNIT – I

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance-Need for public awareness.

Natural Resources:

Forest resources: deforestation – Mining, dams and other effects on forest and tribal people.
Water resources: Use and over utilization of surface and groundwater.
Food resources: World food problems, effects of modern agriculture, fertilizer-pesticide problems.
Energy resources: renewable and nonrenewable energy sources.
Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT-II

Ecosystems, Biodiversity and its conservation: Definition of Ecosystem and its structure, Functions
Biodiversity Definition-Value of biodiversity, India as a mega-diversity nation, Threats to biodiversity, Conservation of biodiversity

UNIT-III

Environmental Pollution: Definition, Cause, Effects of Air pollution, Water pollution, Noise pollution, Radioactive pollution, Role of an individual in prevention of pollution.

Solid Waste Management: Sources, effects and control measures of urban and industrial waste.

UNIT-IV

Social Issues and the Environment: Air (Prevention and Control of Pollution) Act 1981. –Water (Prevention and control of Pollution) Act 1974,EPA act 1986 ,Issues involved in enforcement of environmental legislation**,** Rain water harvesting, Global Environmental challenges climate change and mitigations and Adaptations (Engineering technologies)

UNIT-V

Human population and the Environment:

Population growth, Women and child welfare, Role of Information technology in environment and human health Awareness to Environmental Assessment& clearance ,Audit .Environmental Governance in India

E-Waste management Rules (Biomedical Waste, Solid Waste)

Field work: A mini project related to Environmental issues / To visit a local polluted site (Submission of project by every student)

TEXT BOOKS

1. Environmental Studies for undergraduate courses by ErachBharucha,UGC.
2. A Textbook of Environmental Studies by Dr.S.AzeemUnnisa,Acadamic publishing company.
3. Environmental Studies by P.N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai.
4. A Textbook EIA Notification 2006(2019).

REFERENCE BOOKS

1. Text Book of Environmental Studies by Deeshita Dave & P. UdayaBhaskar, Cengage learning.
2. Glimpses of Environment by K.V.S.G. Murali Krishna Published by Environmental Protection Society, Kakinada, A.P.
3. Environmental Studies by Benny Joseph, Tata McGraw Hill Co, New Delhi.

WEB RESOURCES

UNIT-1: MULTI DISPLINARY NATURE OF ENVIRONMENT and NATURAL RESOURCES

http://www.defra.gov.uk/environment/climatechange

UNIT-2:ECOSYSTEM, BIODIVERSITY AND ITS CONSERVATION

http://conbio.net/vl/ and www.biodiversitya-z.org/content/biodiversity

UNIT-3: ENVIRONMENTAL POLLUTION

https://www.omicsonline.org/environment-pollution-climate-change.php and

UNIT-4: Social Issues and the Environment

http://www.publichealthnotes.com/solid-waste-management/

UNIT-5: HUMANPOPULATION AND THE NVIRONMENT

http://IPCC.com

I Year II Semester
Numerical Methods and Multi-variable Calculus
(Common to CE, ME, ECE, CSE, &IT)

Course Category	Basic Sciences	**Course Code**	19BM2T02
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Differentiation, Integration	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2	The skills derived from the course will help the student form a necessary base to develop analytic and design concepts.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	apply Newton, Gauss and Lagrange interpolation formulae to find interpolating polynomials for the given data.	K3
CO2	find the approximate roots of transcendental equations by using different numerical methods	K2
CO3	solve ordinary differential equations by using different numerical schemes	K3
CO4	Find areas and volumes using double and triple integrals	K2
CO5	apply a range of techniques to find solutions of standard PDEs	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I
Interpolation
Introduction– Errors in polynomial interpolation – Finite differences – Forward differences– Backward differences –Central differences – Symbolic relations and separation of symbols – Differences of a polynomial- Newton's formulae for interpolation –Gauss formulae for interpolation- Interpolation with unequal intervals – Lagrange's interpolation formula.

UNIT II
Solution of Algebraic and Transcendental Equations
Introduction- Bisection method – Method of false position – Secant method- Iteration method – Newton-Raphson method (One variable).

UNIT III

Numerical Integration and solution of Ordinary Differential equations

Trapezoidal rule- Simpson's 1/3rd and 3/8th rule-Solution of ordinary differential equations by Taylor's series-Picard's method of successive approximations-Euler's method - Runge-Kutta method (second and fourth order).

UNIT IV

Multiple integrals

Multiple integrals: Double and triple integrals – Change of variables – Change of order of integration.
Applications: Finding Areas and Volumes.

UNIT V

Partial Differential Equations

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions –solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

TEXT BOOKS

1. **B. S. Grewal**, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India

REFERENCE BOOKS

1. **Micheael Greenberg**, Advanced Engineering Mathematics, 9th edition, Pearson edn
2. **Dean G. Duffy**, Advanced engineering mathematics with MATLAB, CRC Press
3. **Peter O'neil**, Advanced Engineering Mathematics, Cengage Learning.
4. **Srimanta Pal, Subodh C. Bhunia**, Engineering Mathematics, Oxford University Press.
5. **T.K.V. Iyengar et. al.,** Engineering Mathematics Volume I & III S Chand Publications.
6. T.Amarnath, **An Elementary Course in Partial Differential Equations, Narosa Publications**

WEB RESOURCES

UNIT I: Interpolation
https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods/Interpolation
UNIT II: Solution of Algebraic and Transcendental Equations
https://en.wikibooks.org/wiki/Numerical_Methods/Equation_Solving
https://www.slideshare.net/100005232690054/algebraic-and-transcendental-equations
UNIT III: Numerical Integration and solution of Ordinary Differential Equations
https://nptel.ac.in/courses/111107063/
UNIT III: Multiple Integrals
https://en.wikipedia.org/wiki/Multiple_integral
http://tutorial.math.lamar.edu/Classes/CalcIII/MultipleIntegralsIntro.aspx
UNIT V: **Partial Differential Equations**
https://en.wikipedia.org/wiki/Partial_differential_equation

I Year II Semester
Integral Transforms and Vector Calculus
(Common to CE, EEE, ME, ECE, CSE & IT)

Course Category	Basic Sciences	**Course Code**	19BM2T03
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2	The skills derived from the course will help the student form a necessary base to develop analytic and design concepts.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	examine the properties of Laplace transformation	K3
CO2	solve ordinary differential equations by using Laplace transformation technique	K2
CO3	expand a periodic function as a Fourier series and find Fourier transform of a given function.	K3
CO4	understand vector differential properties of scalar and vector point functions and their applications.	K2
CO5	apply Green's, Stokes and Divergence theorem to evaluate line, surface and volume integrals.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I
Laplace transforms: Laplace transforms of standard functions – Properties - Periodic functions - Unit step function – Dirac's delta function.

UNIT II
Inverse Laplace transforms: Inverse Laplace transforms – Properties – Convolution theorem (without proof).
Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT III
Fourier Analysis: Introduction- Periodic functions – Dirichlet's conditions - Fourier series of a function, even and odd functions –Change of interval – Half-range sine and cosine series. Fourier integral theorem (without proof) – Fourier

sine and cosine integrals – sine and cosine transforms – Inverse transforms.

UNIT IV

Vector Differentiation: Gradient - Directional derivative - Divergence – Curl – Laplacian and second order operators – Vector identities.

UNIT V

Vector Integration: Line integral – Work done – Potential function – Area, Surface and volume integrals - Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and related problems.

TEXT BOOKS

1. **B.S.Grewal**, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India

REFERENCE BOOKS

1. **Micheael Greenberg**, Advanced Engineering Mathematics, 9th edition, Pearson edn
2. **Dean G. Duffy**, Advanced engineering mathematics with MATLAB, CRC Press
3. **Peter O'neil**, Advanced Engineering Mathematics, Cengage Learning.
4. **Srimanta Pal, Subodh C.Bhunia**, Engineering Mathematics, Oxford University Press.
5. **T.K.V. Iyengar et. al.,** Engineering Mathematics Volume I & III S Chand Publications.
6. **Murray R Speigel,** Schaum's Outline of Vector Analysis, Schaum's Outline.
7. **Shanti Narayan**, Integral Calculus – Vol. 1 & II

WEB RESOURCES

UNIT I: Laplace transforms

https://en.wikipedia.org/wiki/Laplace_transform

https://web.stanford.edu/~boyd/ee102/laplace.pdf

UNIT II: Inverse Laplace transforms

https://www.intmath.com/laplace-transformation/7-inverse-laplace-transform.php

Unit – III: Fourier Series

https://www.mathsisfun.com/calculus/fourier-series.html

https://lpsa.swarthmore.edu/Fourier/Xforms/FXformIntro.html

UNIT IV: Vector Differentiation

https://en.wikipedia.org/wiki/Vector_calculus

UNIT V: Vector Integration

https://en.wikipedia.org/wiki/Divergence_theorem

http://tutorial.math.lamar.edu/Classes/CalcIII/StokesTheorem.aspx

I Year II Semester
ENGINEERING MECHANICS
(Common to CE & ME)

Course Category	Engineering Science	**Course Code**	19ME2T02
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Physics and Applied Mathematics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To study forces, free body diagrams & equations of equilibrium of coplanar systems and its applications.
2	To study Trusses, friction and its applications.
3	To learn about centroid and moments of Inertia of simple and composite figures.
4	To learn various paths of velocity and acceleration computation.
5	To study about work, energy and particle motion for engineering applications.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Analyze the Forces, Free Body Diagrams & Equations of Equilibrium of Coplanar Systems.	k4
CO2	Analyze the trusses, friction and its applications.	k4
CO3	Evaluate the centroid and moments of Inertia of Composite Figures.	k5
CO4	Determine the paths of velocity and acceleration computation.	k5
CO5	Adapt the concepts of work, energy and particle motion for engineering applications.	k6

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	-	-	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	1	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	-	-	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	-	3
CO5	2	1	1	2	-	-	-	-	-	-	-	-	-	2

COURSE CONTENT

UNIT I

Introduction to Engineering Mechanics: Basic Concepts of mechanics, System of Forces.

Resultant System of Forces: Resultant of Coplanar Concurrent Force System - Moment of a Force, Couple, Varignon's Theorem, Resultant of Coplanar Non-Concurrent Force System.

Equilibrium System of Forces: Equations of Equilibrium of Coplanar Systems, Free Body Diagrams, Lami's Theorem, Equilibrium of Connected Bodies.

UNIT II

Friction: Introduction**,** types of friction, Coulomb's laws of dry friction, coefficient of friction, cone of friction.

Trusses: Introduction, Assumptions and Equilibrium analysis of plane trusses by using method of joints.

UNIT III

Centroid: Introduction**,** Centroids of simple and composite sections.

Centre of Gravity: Simple bodies and Composite bodies, Pappus Theorem.

Moment of Inertia: Definition – Transfer Theorem, Perpendicular Theorem, Polar Moment of Inertia, Moment of Inertia of Simple and Composite Figures, mass moment of inertia of simple bodies.

UNIT IV

Kinematics: D'Alembert's Principle, Rectilinear Motion and curvilinear motion, Motion with Uniform Velocity, Motion with Uniform Acceleration.

Kinetics: Analysis as a Particle and Analysis as a Rigid Body in Translation, Equations of Plane Motion – Fixed Axis Rotation.

UNIT V

Work – Energy Method: Equations for Translation, Motion of Connected Bodies Fixed Axis Rotation and Plane Motion. Impulse momentum method.

TEXT BOOKS

1. Engineering Mechanics - S.Timoshenko, D.H.Young., 5th Edition - , Mc Graw Hill.
2. Engineering Mechanics - S. S. Bhavikatti, K G Rajasekharappa, Revised Edition, New Age International.

REFERENCE BOOKS

1. Engineering Mechanics, N.H.Dubey, McGraw Hill, 2013.
2. Engineering Mechanics, A.K.Tayal, 14th edition, 2nd reprint, Umesh Publications, 2012.
3. Engineering Mechanics, R.K.Bansal, 3rd edition, Laxmi Publications, 1996.
4. Engineering Mechanics: Statics & Dynamics, A. Nelson, Tata McGraw-Hill Education, 2009.
5. Engineering Mechanics, Fedinand . L. Singer, Harper – Collins.

WEB RESOURCES

http://nptel.ac.in/courses/Webcourse-contents/IITKANPUR/engg_mechanics/ui/Course_home_3.htm
http://nptel.ac.in/courses/122104015/
https://nptel.ac.in/courses/122104015/
https://freevideolectures.com/course/2264/engineering-mechanics
https://nptel.ac.in/courses/112103108/3
https://nptel.ac.in/courses/115104094/54

I Year II Semester
ENGINEERING PHYSICS
(Common to CE & ME branches)

Course Category	BASIC SCIENCES	**Course Code**	19BP2T01
Course Type	Theory	**L-T-P-C**	3 - 0 -0-3
Prerequisites	Intermediate Physics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Study the Crystal Structures, Properties and their relationship exhibited by Solid State materials for their utility.
2	Impart knowledge on magnetic materials with characteristic utility in appliances.
3	Simple harmonic motion and its adaptability for improved acoustic quality of concert halls- Impart concepts of flaw detection techniques using ultrasonic's.
4	Impart knowledge in basic concepts of LASERs along with its Engineering applications- Familiarize types of sensors for various engineering applications
5	Impart the knowledge of Nanomaterials, Properties, characterization Techniques and Applications

COURSE OUTCOMES		**Cognitive Level**
Upon successful completion of the course, the student will be able to:		
CO1	Apply the basics of crystal structures and X ray diffraction technique for material studies.	Application(K3)
CO2	Analyze the materials based on their magnetic properties and use them in possible applications.	Analysis(K3)
CO3	Analyze the factors behind acoustic defects and different ultrasonic testing techniques of materials using NDT	Analysis(K3)
CO4	Understand the basics principles of laser mechanism and Sensors for applications in engineering.	Understanding(K2)
CO5	Apply the knowledge of Nanomaterials and their properties for applications in engineering	Application(K3)

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	-	1	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	1	1	-	-	-	-	-	-	-	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I
CRYSTALLOGRAPHY & X-RAY DIFFRACTION
Introduction-Basis and lattice – Unit cell - Coordination number -Packing fraction -Bravais lattice-Crystal Systems – packing fractions of SC,BCC and FCC-Crystal directions and planes-Miller indices – Separation between successive (h k l) planes – Bragg's law - Bragg's X-ray spectrometer.

UNIT II

MAGNETIC PROPERTIES

Introduction-Magnetic-dipole-moment-Magnetization-Magnetic susceptibility and permeability- Origin of permanent magnetic moment -Classification of Magnetic materials(Analytical) - Wiess theory – Domain theory -Hysteresis-eddy currents- soft and hard magnetic materials - applications.

UNIT III

ACOUSTICS

Introduction – Reverberation - Reverberation time - Sabine's formula (Jaggers' Method using Eyrings approximation)– absorption coefficient and its determination- factors affecting acoustics of buildings and their remedies.

ULTRASONICS

Introduction-Production of ultrasonic's by Magneto-striction and piezoelectric methods – Detection of ultrasonic's-Non-Destructive Testing- pulse echo system through transmission and reflection modes - Applications.

UNIT IV

LASERS

Introduction-Characteristics–Spontaneous and Stimulated emission of radiation – population inversion - Pumping Mechanisms - Ruby laser – Helium Neon laser –Semiconductor laser– Applications

SENSORS (Qualitative description only):

Introduction-Strain and Pressure sensors-Piezoelectric-Magnetostrictive sensors- Temperature sensor-smoke and fire detectors-Applications.

UNIT V

PHYSICS OF NANOMATERIALS

Introduction to Basics of Nano materials, Properties - Preparation methods (Sol Gel Technique, Ball Milling) and characterization Methods Scanning tunneling Microscopy, Atomic Force Microscopy – CNTs Preparation (Arc Discharge method) and properties - Applications of NanoMaterials (CNTs).

TEXT BOOKS

1. "A text book of Engineering Physics" by P G Kshirsagar& M N Avadhanulu, S Chand & Company Ltd
2. **"**Solid State Physics" by SO Pilai., - New age International Publishers.
3. "Engineeing Physics by P.K.Palanisamy, Scitech publications (New Edition 2019)

REFERENCE BOOKS

1. "Sensor and Transducers" by Ian R Sinclair, Elsevier (Newnes) 3rd Eds
2. Kettles Introduction to Solid state Physics-Charles Kittel,Wiley India Edition

WEB RESOURCES

1. http://youtu.be/OTDVov_kw6A
   https://slideplayer.com/slide/3866455/64/video/CHAPTER+3%3A+CRYSTAL+STRUCTURES+%26amp%3B+PROPERTIES.mp4
   https://youtu.be/DYTCF01gdr0
2. https://nptel.ac.in/courses/113106032/15%20-%20Magnetic%20Properties.pdf
3. https://www.svce.ac.in/departments/physics/downloads/Notes/Unit-IV/UNIT%20IV%20Acoustics.pdf
4. https://youtu.be/UheTlVwukWg
   http://engineering.nyu.edu/gk12/amps-cbri/pdf/Intro%20to%20Sensors.pdf
5. https://nccr.iitm.ac.in/2011.pdf
   https://youtu.be/lFYs3XDu4fQ

I Year II Semester
BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Course Category	Engineering Sciences	**Course Code**	19EE2T02
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NA	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn the basic principles of electrical circuit analysis.
2	To understand constructional details and operating principle of DC machines & Transformers.
3	To understand constructional details and operating principle details of alternator and 3-Phase induction motor.
4	To study operation of PN junction diode, half wave, full wave rectifiers, PNP and NPN transistors and various semiconductor devices.
5	To study the operation of OP-AMPs.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze various electrical circuits	Analyzing
CO2	Understand constructional details and operating principle of DC machines, single phase transformer, tests and analyze their performance.	Analyzing
CO3	Explain operation of Three phase AC machines.	Understanding
CO4	Analyze operation of half wave, full wave bridge rectifiers and Explain single stage CE amplifier and concept of various semiconductor devices.	Analyzing
CO5	Analyze operation of OP-AMPs.	Analyzing

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1	-	-	-	-	-	-	-	1	1	-
CO2	3	2	2	2	-	-	-	-	-	-	-	1	1	-
CO3	3	2	2	2	-	-	-	-	-	-	-	1	1	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-	1	-

COURSE CONTENT

UNIT I

Electrical Circuits

Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – inductive networks – capacitive networks – series – parallel circuits – star-delta and delta-star transformations.

UNIT II

DC Machines & Transformers

Constructional details and operating principle – EMF equation –DC motor – torque equation – applications - speed control methods of DC motor – Swinburne's Test.

Constructional details and operating principle of single phase transformers – EMF equation – equivalent circuit – Losses – OC & SC tests – efficiency.

UNIT III

AC Machines

Constructional details and operating principle of alternators – types –Regulation of alternator by synchronous impedance method.

Principle of operation of 3-Phase squirrel cage induction motor – electromagnetic torque equation - power flow - brake test - efficiency calculation – applications.

UNIT IV

Semiconductor Devices

PN junction diodes – characteristics – half wave and full wave rectifiers - PNP and NPN junction transistor, transistor as an amplifier – transistor amplifier – frequency response of CE amplifier – concepts of feedback amplifier – SCR – MOSFET - IGBT.

UNIT V

Operational Amplifiers

Introduction to operation amplifiers (Ideal OP-AMP) – Characteristics – applications (inverting, non-inverting, integrator and differentiator).

TEXT BOOKS

1. William Hayt and Jack E. Kemmerley, Engineering Circuit Analysis, Mc Graw Hill Company, 6th Edition.
2. Surinder Pal Bali, Electrical Technology, Vol-I, Vol-II, Pearson Publications, 1st Editiom.
3. Basic Electrical and Electronics Engineering by M.S. Sukhija and T.K. Naga Sarkar, Oxford University Press.
4. R.L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits, PEI/PHI 2006, 9th Edition.

REFERENCE BOOKS

1. John Bird, Electrical Circuit Theory and Technology, Routledge Taylor and Francis Group, 5th Edition.
2. M.S.Naidu and S.Kamakshiah, Basic Electrical Engineering, TMH Publications, 1st Edition.
3. Rajendra Prasad, Fundamentals of Electrical Engineering, PHI Publications, 2nd edition.
4. R. S. Sedha, A Text Book of Electronic Devices and Circuits, S.Chand & Co. 2nd Edition.
5. David A. Bell, Electronic Devices and Circuits, Oxford University Press, 5th Edition.

WEB RESOURCES

1. http://www.ncert.nic.in/html/learning_basket/electricity/electricity/machine/motor.html
2. www.electricaleasy.com
3. www.nptel.ac.in/courses/108108076/
4. https://nptel.ac.in/courses/122106025/

I Year II Semester
MATERIALS SCIENCE & METALLURGY
(only for ME)

Course Category	Professional Core	**Course Code**	19ME3T04
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Chemistry	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To know the basic concepts of bonds in metals, alloys and understand the basic requirements for the formation of solid solutions and other compounds.
2	To understand the regions of stability of the phases that can occur in an alloy system in order to solve the problems in practical metallurgy.
3	To study the basic differences between cast irons, steels, non-ferrous metals and alloys, their properties and practical applications.
4	To study the affect of various alloying elements on iron-iron carbide system. To understand the various heat treatment and strengthening processes used in practical applications.
5	To study the basic concepts of composites and powder metallurgy so as to use them for practical applications.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Define various types of bonds and crystal structure of metals and its alloys.	k2
CO2	Construct equilibrium diagrams by studying various phases while drawing it.	k3
CO3	Make use of applications of Ferrous and Non-ferrous metals and its alloys.	k3
CO4	Analyze various heat treatment processes of alloys.	k4
CO5	Classify composites and explain powder metallurgy.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	1	1	-	1	-	-	-	-	-	1	1	1
CO2	2	2	1	1	1	-	-	-	-	-	-	-	2	-
CO3	3	1	1	2	1	-	-	-	-	-	-	-	1	-
CO4	3	2	2	1	1	-	-	-	-	-	-	-	1	-
CO5	2	1	1	2	1	-	-	-	-	-	-	-	2	1

COURSE CONTENT

UNIT I

Structure of Metals and Constitution of Alloys: Bonds in Solids – Metallic bond - crystallization of metals, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys – determination of grain size. Types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds.

UNIT II

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphism alloy systems, equilibrium cooling and heating of alloys, Lever rule, eutectic systems, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule. Study of important binary phase diagrams of Cu-Ni-, Bi-Cd and Fe-Fe3C.

UNIT III

Ferrous Metals and Alloys: Structure and properties of White Cast iron, Malleable Cast iron, Grey cast iron, Nodular cast iron, Alloy cast irons. Classification of steels, properties and applications of plain carbon steels.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys.

UNIT IV

Heat treatment of Alloys: Annealing, normalizing, Hardening, TTT diagrams, tempering, Hardenability, surface - hardening methods, Age hardening treatment.

UNIT V

Powder Metallurgy: Introduction, Principle, manufacture of powders, steps involved, compaction and sintering, advantages and applications.

Composite Materials: Classification of composites : particle – reinforced materials, fiber reinforced materials , metal – matrix composites and C – C composites, various methods of component manufacture of composites - Hand layup process, Filament winding process, Continuous pultrusion process.

TEXT BOOKS

1. Introduction to Physical Metallurgy - Sidney H. Avner , McGrawHill, 2017.
2. Material Science and Metallurgy for Engineers by V.D Kodgire and S.V Kodgire 39th Edition.

REFERENCE BOOKS

1. Essential of Materials science and Engineering ,Pradeep P Fulay and Donald R.Askeland, Cengage publications, 2nd Edition.
2. Materials Science and Engineering , Callister & Balasubramaniam, Wiley Publishers, 2nd Edition.
3. Material Science for Engineering Students , Fischer , Elsevier Publishers, 1st Edition.
4. Materials Science and Engineering V. Raghavan Prentice-Hall of India Pvt. Ltd., 5th Edition 2004.
5. Material Science and Metallurgy , U. C. Jindal – Pearson Publications, 2011.

WEB RESOURCES

1. http://nptel.ac.in/courses/113105024/7.
2. http://nptel.ac.in/courses/112104122/12.
3. http://nptel.ac.in/courses/113106031/17.
4. http://nptel.ac.in/courses/113104068/36.

I Year II Semester
ENGINEERING PHYSICS LABORATORY
(Common to CE & ME)

Course Category	BASIC SCIENCES	**Course Code**	19BP2T01
Course Type	Lab	**L-T-P-C**	0 - 0 - 3-1.5
Prerequisites	Intermediate Physics	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES		
1	The student will have exposure to various experimental skills which is essential for an Engineering student.	
2	To gain practical knowledge by applying the experimental methods to correlate with the Theoretical Physics.	
3	Apply the Analytical techniques and graphical analysis to the experimental data	
COURSE OUTCOMES		**Cognitive Level**
Upon successful completion of the course, the student will be able to:		
CO1	Understand the basics of Mechanics, Elasticity, Diffraction using instruments like Fly wheel, Stewart Gee's, Grating	K2
CO2	Understand the basics of Waves and Oscillations in Physics using instruments like Volume Resonator, Sonometer.	K3
CO3	Determine the Magnetic and Dielectric constants of materials	K3

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	-	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT:

(Any 10 of the following listed 12 experiments)

1. Determination of Rigidity modulus of a material- Torsional Pendulum.
2. Determination of Young's modulus by method of single cantilever oscillations.
3. Determination of Acceleration due to Gravity and Radius of Gyration - Compound Pendulum.
4. Verification of laws of vibrations in stretched strings – Sonometer.
5. Determination of ultrasonic velocity in liquid (Acoustic grating)
6. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
7. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
8. Determination of dielectric constant by charging and discharging method
9. Determination of wavelength of Laser by diffraction grating
10. Determination of particle size using Laser.
11. Determination of Moment of Inertia of a Fly Wheel.
12. Determination of Velocity of sound –Volume Resonator.

TEXT BOOKS

1. Laboratory Manual of Engineering Physics by Dr.Y.Aparna & Dr.K.Venkateswara Rao (V.G.S Publishers)
2. College customized manual

WEB RESOURCES

1. https://youtu.be/P-eJIXZimmQ
2. https://youtu.be/iUhfstf10rk
3. https://www.youtube.com/watch?v=BX4QPdP7fT8
4. https://youtu.be/toggy3WVxV4
5. https://www.youtube.com/watch?v=AYQLmFqFtlw
6. https://www.youtube.com/watch?v=9MBE5t1Sv_w

I Year II Semester
ENGINEERING WORKSHOP
(Only for ME)

Course Category	Engineering Science	**Course Code**	19ME2L02
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To familiarize with the basic material removal/shaping processes.
2	To study the various tools and equipment used in different hands on sessions.
3	To develop a skill in dignity of labor, precision, safety at work place.
COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	
CO1	Practice on manufacturing of components using workshop trades including fitting and carpentry.
CO2	Design different types of models by using workshop trades including black smithy and tin smithy.
CO3	Apply basic electrical engineering knowledge for house wiring practice.

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	3	-	3	-	-	-	-	-	-	-	3	3
CO2	3	-	3	-	3	-	-	-	-	-	-	-	3	3
CO3	3	-	3	-	3	-	-	-	-	-	-	-	3	3

COURSE CONTENT

LIST OF EXPERIMENTS

A. Carpentry:
1. T-Lap Joint
2. Cross Lap Joint
3. Dovetail Joint
4. Mortise and Tenon Joint

B. Fitting:
1. V Fit
2. Square Fit
3. Half Round Fit
4. Dovetail Fit

C. Black Smithy:
1. Round rod to Square
2. S-Hook
3. U- Hook
4. Round Rod to Flat Ring

D. House Wiring:
1. Parallel Connection of three bulbs
2. Series Connection of three bulbs
3. Stair Case wiring
4. Florescent Lamp Fitting

E. Tin Smithy:
1. Square Box without lid
2. Open Scoop
3. Taper Tray
4. Funnel

Note: At least two exercises to be done from each trade**.**

I Year II Semester
CONSTITUTION OF INDIA
(Common to all branches)

Course Category	Humanities including Management	**Course Code**	19HM2T05
Course Type	Theory	**L-T-P-C**	2 -0 -0-0
Prerequisites		**Total Marks(Internal assessment)**	100

COURSE OUTCOMES		**Cognitive Level**
On successful completion of the course, the student will be able to		
CO 1	Understand the evolution of Constitution of India	K2
CO 2	Make use of their Fundamental rights.	K3
CO 3	Understand the functioning of the Union Government	K2
CO 4	Understand the functioning of the State and local self Government.	K2
CO 5	Understand the value of Indian Constitution in functioning of the country.	K2

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	3	-	3	-	1	-	2	-	-
CO2	-	-	-	-	-	1	-	2	1	1	-	1	-	-
CO3	-	-	-	-	-	1	-	1	1	1	-	-	-	-
CO4	-	-	-	-	-	1	-	1	1	1	-	-	-	-
CO5	-	-	-	-	-	1	1	1	1	1	-	2	-	-

COURSE CONTENT :

UNIT – I
Introduction to Indian constitution: Meaning of the term constitution - History and development – Preamble of the Constitution – Constituent Assembly – The salient features of Indian Constitution.

UNIT –II
Fundamental Rights and Directive principles of state policy: Individual and Collective Rights – Limitations of the fundamental Rights – Judicial Interpretation of Fundamental Rights.

UNIT –III
Union Government: Union Legislature – Lok sabha and Rajya sabha (powers and functions) – President of India (powers and functions) – Prime minister of India (powers and functions) – Union Judiciary (supreme court powers and functions).

UNIT – IV STATE AND LOCAL SELF GOVERNMENT:

State Government: State Legislature (Legislative Assembly / Vidhan Sabha, Legislative Council / Vidhan Parishad) – Powers and functions of state legislature – The Chief Minister of the state (powers and functions)

Local Self Government: Election commission of India (Powers and Functions)- The Union Public Service Commission (Powers and Functions)

UNIT – V WORKING OF THE INDIAN CONSTITUTION

The values of the Indian Constitution and Ushering of Social Revolution in India – Nature and Role of Higher Judiciary in India – Amendments (Recent)

REFERENCE BOOKS :

1. 'Indian Polity' by Laxmikanth
2. 'Indian Administration' by Subhash Kashyap
3. 'Indian Constitution' by D.D. Basu
4. 'Indian Administration' by Avasti and Avasti

WEB RESOURCES:

1. https://www.clearias.com/historical-background-of-indian-constitution/
2. https://www.civilserviceindia.com/subject/General-Studies/notes/functions-and-responsibilities-of-the-union-and-the-states.html
3. https://www.tutorialspoint.com/indian_polity/indian_polity_how_constitution_works

II Year I Semester
Complex Variables & Statistical Methods
(For ME only)

Course Category	Basic Sciences	**Course Code**	19BM3T05
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2	The skills derived from the course will help the student form a necessary base to develop analytic and design concepts.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Discuss the continuity, differentiability and analyticity	K3
CO2	Evaluate the integrals over a domain, Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues	K2
CO3	Find the confidence intervals for a statistic from the given population	K3
CO4	Apply the concept of hypothesis testing to real world problems (large samples)	K2
CO5	Apply the concept of hypothesis testing to real world problems (small samples)	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I

Functions of a complex variable: Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates. Harmonic and conjugate harmonic functions – Milne – Thompson method.

UNIT II

Complex Integration and Power Series: Line integral – Cauchy's integral theorem, Cauchy's integral formula, Generalized integral formula (all without proofs)- Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series – Residue theorem.

UNIT III

Sampling Distributions: Review of Normal distribution – Population and samples – Sampling distribution of mean (with known and unknown variance), proportion, variances – Sampling distribution of sums and differences -Point and interval estimators for means, variances, proportions.

UNIT IV

Tests of Hypothesis (Large Samples): Type I and Type II errors -Maximum error- One tail, two-tail tests – Tests concerning one mean and proportion, two means- Proportions and their differences using Z-test.

UNIT V

Tests of Hypothesis (Small Samples): Tests concerning one mean and proportion, two means- Proportions and their differences using Student's t-test – F-test and Chi -square test.

TEXT BOOKS

1. **Probability and Statistics for Engineers: Miller and John E. Freund, Prentice Hall of India.**
2. **Murugesan.K,** Probability and Statistics & Random processes, Anuradha Publications.

REFERENCE BOOKS

1. **T.K.V. Iyengar et. al.,** Probability and Statistics, S Chand Publications.
2. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
3. **B.S. Grewal**, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
4. **Jay L. Devore,** Probability and Statistics for Engineering and Sciences, 8th Edition, Cengage Learning. ISBN 13: 978-81-315-1839-7.
5. **Ronald E. Walpole, Sharon L. Mayers and Keying Ye**, Probability and statistics for Engineers and Scientists, Perarson.

WEB RESOURCES

UNIT I: Functions of a complex variable
https://en.wikipedia.org/wiki/Complex_analysis

UNIT II: Integration and Series Expansions:
https://en.wikipedia.org/wiki/Contour_integration
http://mathonline.wikidot.com/complex-power-series

UNIT III: Sampling Theory
https://en.wikipedia.org/wiki/Normal_distribution
https://en.wikipedia.org/wiki/Sampling_(statistics)
https://nptel.ac.in/courses/111104073/

UNIT IV: Tests of Hypothesis (Large Samples)
https://en.wikipedia.org/wiki/Statistical_hypothesis_testing

UNIT V: Tests of Hypothesis (Small Samples)
https://machinelearningmastery.com/statistical-hypothesis-tests/

II Year I semester
MECHANICS OF SOLIDS

Course Category	Professional Core	**Course Code**	19ME3T05
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Mechanics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To study the various types of stresses and strains subjected to axial loading and understand the strain energy concepts.
2	To study different beams, draw the shear force, bending moment diagrams and correlate the shear force, bending moment and rate of loading.
3	To study the bending and shear stresses on various cross sections of the beam.
4	To determine slope, deflection at any point on the determinate beams using various methods and stresses due to torsion.
5	To calculate stresses developed in thin and thick cylinders subjected to internal pressure.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain various types of stresses due to axial loading and the concept of strain energy.	k2
CO2	Develop shear force and bending moment diagrams for determinate beams subjected to different types of loads .	k3
CO3	Analyze the bending and shear stresses on different cross sections of the beams.	k4
CO4	Examine the slope and deflection of the beam by various methods subjected to point load, UDL, and uniformly varying loads and stresses due to torsion.	k4
CO5	Determine the stresses in thin and thick cylinders subjected to internal pressure.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1	1	1	-	-	-	-	-	-	1	1
CO2	3	3	2	2	1	1	-	-	-	-	-	-	1	1
CO3	3	3	2	2	1	1	-	-	-	-	-	-	1	1
CO4	3	3	2	2	1	1	-	-	-	-	-	-	1	1
CO5	3	3	2	2	1	1	-	-	-	-	-	-	1	1

COURSE CONTENT

UNIT I

Simple Stresses & Strains: Types of stresses & strains – Hooke's law – stress – strain diagram for ductile and brittle materials – Factor of safety – Poisson's ratio & volumetric strain – Relation between elastic constants - Bars of varying section – composite bars – Temperature stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses (both analytical and graphical methods). Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT II

Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L, uniformly varying loads and combination of these loads – Point of contraflexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT III

Flexural Stresses: Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R, Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

UNIT IV

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load.

Torsion: Introduction – Derivation of torsion equation - Torsion of Circular shafts - Stresses and strains in pure Shear.

UNIT V

Thin & Thick Cylinders: Thin cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders. Thick cylinders – Lame's equation – cylinders subjected to inside & outside pressures.

TEXT BOOKS

1. Mechanics of Materials, Ferdinand P Beer, Johnston, Dewolf and Mazurek, 7th Edition, Mc Graw Hill.
2. Strength of Materials, S. Ramamrutham, Dhanpat Rai and Co. Publications, 18th Edition.

REFERENCE BOOKS

1. Strength of Materials, U.C. Jindal, Umesh Publications, 1st Edition.
2. Strength of Materials, D S Prakash Rao, Volume 1, University Press.
3. Strength of Materials, R.K.Bansal, Laxmi Publications, 4th Edition.
4. Strength of Materials, Andrew Pytel and Ferdinond L. Singer Longman, 4th Edition.
5. Mechanics of Materials, Gere & Timoshenko, CBS Publications, 2nd Edition.

WEB RESOURCES

1. http://nptel.ac.in/courses/112107147/1
2. http://nptel.ac.in/courses/112107147/7
3. http://nptel.ac.in/courses/112107147/23
4. http://nptel.ac.in/courses/105106116/
5. https://en.wikipedia.org/wiki/Strength_of_materials

II Year I Semester
THERMODYNAMICS

Course Category	Professional Core	**Course Code**	19ME3T06
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Physics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand the basic concepts like thermodynamic system, its boundary and related fundamental definitions.
2	To learn the first law for different thermodynamic systems and apply steady flow energy equation for various mechanical components.
3	To understand the second law statements and the associated terms to apply the principles to heat engines.
4	To understand the process of steam formation and its representation on property diagrams with various phase changes.
5	To understand the concept of air standard cycles and calculate the efficiency.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Illustrate basic concepts of thermodynamics and thermometry.	k2
CO2	Apply first law of thermodynamics for different thermodynamic systems.	k3
CO3	Analyze various concepts associated with second and third laws of thermodynamics.	k4
CO4	Analyze the mixture of perfect gases using property diagram with the use of steam tables and charts.	k4
CO5	Determine the efficiency of various air standard cycles.	k5

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1	-	1	1	-	-	-	-	-	2	-
CO2	2	2	2	2	-	1	1	-	-	-	-	-	2	-
CO3	2	2	2	2	-	-	-	-	-	-	1	1	2	-
CO4	1	2	2	1	-	-	-	-	-	-	-	1	2	-
CO5	2	2	2	2	-	-	-	1	-	-	-	2	2	-

COURSE CONTENT

UNIT I

Introduction: Basic Concepts: System, Boundary, Surrounding, Control Volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, reversibility and Irreversibility, Cycle –Quasi – static Process, Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry –Reference Points – Const. Volume gas thermometer.

UNIT II

First law of Thermodynamics: Joule's Experiment – Corollaries – First law applied to a Process – applied to a flow system– PMM-I, Limitations of first law, Steady Flow Energy Equation. Throttling and free expansion processes –Ideal Gas Equations, deviations from perfect gas model – Vander Waals equation of state.

UNIT III

Thermal Reservoir, Heat Engine, Refrigeration and Heat pump, Parameters of performance. **Second Law of Thermodynamics**: Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties.

Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Causes of irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations, Joule Thompson coefficient – Elementary Treatment of the Third Law of Thermodynamics.

UNIT IV

Pure Substances: P-V-T- surfaces, T-S and h-s diagrams, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Mollier charts – Various Thermodynamic processes and energy Transfer- Mixtures of perfect Gases – Mole Fraction, Mass fraction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes.

UNIT V

Power Cycles : Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Brayton Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles.

TEXT BOOKS

1. Thermodynamics: An Engineering Approach, Yunus A Cengel, Michael A Boles, McGraw-Hill, 9th Edition.
2. Engineering Thermodynamics by PK Nag, McGrawHill Publisher, 6th Edition.

REFERENCE BOOKS

1. Thermodynamics, J.P.Holman, McGrawHill, 4th Edition 1988.
2. Fundamentals of Thermodynamics, G.J.Van Wylen & Richard E Sonntag, Claus Borgnakke, Wiley Publications, 6th Edition 2003.
3. An Introduction to Thermodynamics, Y.V.C.Rao – Universities press, 2004.
4. An Text Book of Engineering Thermodynamics, R K Rajput, Laxmi publications Ltd.,
5. Fundamentals of Engineering Thermodynamics, Volume 1, Michael - J.Moran, Howard N. Shapiro, Wiley Global Education, 7th Edition 2010

WEB RESOURCES

1. http://nptel.ac.in/courses/112105123/1
2. http://nptel.ac.in/courses/Webcourse contents/IITKANPUR/Basic Thermodynamics/ui/TOC.html
3. http://www.nptelvideos.in/2012/12/basic-thermodynamics.html

Note: Use of steam tables and Mollier Chart is allowed

II Year I Semester
FLUID MECHANICS & HYDRAULIC MACHINERY

Course Category	Professional Core	**Course Code**	19ME3T07
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Mechanics & Basic Mathematics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To study different fluid properties and Manometers.
2	To learn about the different types of fluid flows, flow patterns, forces behind the flow, energy equation, Momentum equation and also to find the losses occurs in flow through the pipes.
3	To study the concept of boundary layer theory and hydrodynamic forces acting on vanes along with their performance evaluation.
4	To study different types of hydraulic turbines, draft tube theory, efficiency, governing and performance characteristics.
5	To study types of Pumps, work done, efficiency, performance of pumps & characteristic curves.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Define different fluid properties and also acquire knowledge on buoyancy and flotation.	k1
CO2	Classify the fluid flows, forces behind the flow and derive governing equations and losses in pipes.	k2
CO3	Make use of laminar and turbulent boundary layer concepts and analyze hydro dynamic forces on different vanes.	k3
CO4	Categorize various hydraulic turbines and evaluate their performance.	k4
CO5	Categorize various pumps and evaluate their performance.	k4

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	3	3	3	-	-	-	-	-	-	-	1	-	1
CO3	3	3	1	-	-	2	2	-	-	-	-	3	1	-
CO4	3	3	1	-	-	2	2	-	-	-	-	3	-	2
CO5	3	3	1	-	-	2	2	-	-	-	-	3	-	2

COURSE CONTENT

UNIT I

Fluid Statics: Physical properties of fluids- specific gravity, viscosity and surface tension - vapour pressure and their influence on fluid motion- gauge and vacuum pressure –measurement of pressure- Piezometer, U-tube and differential manometers.

UNIT II

Fluid Kinematics: Fluid flow patterns, Classification of Flows-Steady & Un-Steady, Uniform and Non- Uniform, Laminar, Turbulent, Rotational and Irrotational Flows-Equation of Continuity for One Dimensional Flows.

Fluid Dynamics: Surface and Body Forces-Euler's Equation, Bernoulli's Equations for Flow along a Stream Line, Momentum Equation and Its Application on Force on Pipe Bend. Reynolds Experiment, Darcy's - Weisbach Equation-Minor Losses in Pipes, Pipes in Series, Parallel-Total Energy Line-Hydraulic Gradient Line, Measurement of Flow - Venturimeter, Orificemeter and Pitot Tube.

UNIT III

Boundary Layer Theory: Couette flow for one plate moving and another at rest - Laminar & Turbulent Boundary Layer, Boundary Layer Thickness, Displacement Thickness, Energy Thickness, Momentum Thickness, Separation of Boundary Layer, Buckingham π Theorem.

Impact of Jets: Hydro dynamic forces of Jets on Stationary and moving flat, Inclined, Curved vanes, Jet striking centrally and a tip for Symmetrically and Un-symmetrically vanes, Velocity diagrams, work done and efficiency, Flow over radial vanes.

UNIT IV

Hydraulic Turbines: Classification of turbines, impulse and reaction turbines- Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies , hydraulic design –draft tube theory- functions and efficiency.

Performance of Hydraulic Turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

UNIT V

Centrifugal Pumps: Classification, working, work done – manometric head- losses and efficiencies specific speed- pumps in series and parallel - performance characteristic curves, NPSH.

Reciprocating Pumps: Working, Discharge, slip, indicator diagrams.

TEXT BOOKS

1. Fluid Mechanics- Fundamentals and Applications, Y.A.Cengel & J.M.Cimbala, Tata McGrawhill, 2008.
2. Fluid Mechanics and Hydraulic Machines, R. K. Bansal, Lakshmi Publications, 9th Edition.

REFERENCE BOOKS

1. Fluid Mechanics, F.M.White, Tata Mc Graw Hill, 3rd Edition.
2. Hydraulics and Fluid Mechanics including Hydraulics Machines, P. N. Modi, S. M. Seth, Standard Book House Publishers, 14th Edition.
3. Fluid Mechanics and Fluid Power Engineering, D.S.Kumar, S.K. Kataria & Sons Publications.
4. Engineering Fluid Mechanics K L Kumar, Eurasia Publishing House.
5. Fluid Mechanics: Including Hydraulic Machines, A.K.Jain, Khanna Publications, 12th Edition.

WEB RESOURCES

1. http://nptel.iitm.ac.in/courses
2. http://nptel.iitm.ac.in/courses/105101082/;
3. http://nptel.iitm.ac.in/courses/105101082/;
4. http://www.learnerstv.com/Free-Engineering-Video-lectures-ltv078Page1.htm
5. http://www.learnerstv.com/video/Free-video-Lecture-2630-Engineering.htm
6. http://www.learnerstv.com/video/Free-video-Lecture-2654-Engineering.htm
7. http://ga.water.usgs.gov/edu/hyhowworks.html

II Year I Semester
PRODUCTION TECHNOLOGY

Course Category	Professional Core	**Course Code**	19ME3T08
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Workshop Laboratory	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand fundamentals of casting concepts.
2	To provide insight into sand casting and introduce other casting processes.
3	To impart knowledge on different welding processes.
4	To understand about the importance of rolling, forging and sheet metal operations.
5	To learn the basics of plastic and ceramics processing.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Explain the working principle of different metal casting processes and gating system.	k2
CO2	Illustrate preparation of moulds as per casting design considerations to minimize defects.	k2
CO3	Explain the different welding processes for joining the parts to fabricate the final product.	k2
CO4	Identify different metal forming processes and their application in real time.	k3
CO5	Distinguish the plastics, ceramics to produce the required parts.	k4

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	1	-	1	-	-	-	-	-	-	1	2
CO2	2	2	1	1	1	-	-	-	-	-	-	-	2	-
CO3	3	2	1	1	1	1	-	-	-	-	-	-	1	-
CO4	3	2	2	2	2	1	-	-	-	-	-	-	1	-
CO5	2	1	2	2	2	1	-	-	-	-	-	-	2	1

COURSE CONTENT

UNIT I
Introduction: Importance and Classification of manufacturing processes.
Casting Processes: Steps involved in making a casting, Advantage of casting and its applications.
Pattern: Types, materials used for pattern and allowance.
Cores: Types of cores, core prints, principles and design of gating system, Gating ratio.

UNIT II

Melting and Casting Processes: Methods of melting and types of furnaces, Solidification of castings, Risers- Types, function and design, casting design considerations, basic principles and applications of Shell casting, investment casting, die casting, centrifugal casting, casting defects and remedies.

UNIT III

Welding Processes: Classification of welding processes, types of welds and welded joints, weld bead geometry.
Fusion welding: Basic principles of Arc welding and It's Types, Gas welding, Types of flames, Oxy – Acetylene Gas cutting, Thermit welding, Electron Beam welding, Laser beam welding. -Applications, advantages and disadvantages.
Pressure welding: Resistance welding- Spot welding, seam welding, butt welding, projection welding; Solid State welding- Forge welding, Friction welding, Friction stir welding, Explosive welding; Heat affected zones in welding; Welding defects: causes and remedies. Soldering and brazing.

UNIT IV

Sheet Metal Forming: Introduction, nature of plastic deformation, hot and cold working of metals; Sheet metal working operations: Blanking, piercing, bending, stamping. Spring back and its remedies. Coining, Spinning, types of presses and press tools.
Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements.
Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.
Forging: Principles of forging, tools and dies. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects.

UNIT V

Plastics: Types, properties and their applications, processing of plastics, extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding and blow molding.

Ceramics: Classification of ceramic materials, properties and their application, ceramic powder preparation; Processing of ceramic parts: Pressing, casting, sintering; secondary processing of ceramics: Coatings, finishing.

TEXT BOOKS

1. Manufacturing Technology – Volume I, P.N.Rao 5th Edition, McGraw-Hill Education.
2. Fundamentals of Modern Manufacturing: Materials, Processes and Systems, Mikell P. Groover, John Wiley and Sons Inc, 4th Edition.

REFERENCE BOOKS

1. Manufacturing Engineering and Technology, Kalpak Jain S and Schmid S.R. Pearson, 8th Edition.
2. Manufacturing processes, Amitabha ghosh and Malik, East west press, 2nd Edition.
3. Production Technology, P.C.Sharma ,S Chand Publishing, 8th Edition.
4. Process and Material of Manufacture ,Roy A Lindberg , PHI, 4th Edition.
5. Production Engineering-K.C. Jain, A.K. Chitale , PHI, 2nd Edition.

WEB RESOURCES

1. http://nptel.ac.in/courses/112107145/4
2. http://nptel.ac.in/courses/112107145/5
3. http://nptel.ac.in/courses/112107145/7
4. http://nptel.ac.in/courses/112107145/23#
5. https://onlinecourses.nptel.ac.in/noc19_me52
6. https://swayam.gov.in/nd1_noc19_mm19
7. https://onlinecourses.nptel.ac.in/noc19_me52/course

II Year I Semester
BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

Course Category	Lab Course	**Course Code**	19EE3L02
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Basic Electrical & Electronics Engineering	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To determine the voltage, current and power in star and delta connected loads.
2	To predetermine the efficiency of dc shunt machine using Swinburne's test.
3	To predetermine the efficiency and regulation of 1-phase transformer with O.C and S.C tests.
4	To obtain performance characteristics of DC shunt generator & 3-phase induction motor.
5	To find out regulation of an alternator with synchronous impedance method.
6	To control speed of dc shunt motor using Armature voltage and Field flux control methods.
7	To find out the characteristics of PN junction diode & transistor.
8	To determine the ripple factor of half wave & full wave rectifiers.
9	To find out the band width of transistor CE amplifier.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Determine the voltage, current and power in star and delta connected loads.	K5
CO2	Compute the efficiency of DC shunt machine without actual loading of the machine.	K3
CO3	Estimate the efficiency and regulation at different load conditions and power factors for single phase transformer with OC and SC tests.	K5
CO4	Analyze the performance characteristics to determine critical speed and resistance of DC shunt generator & efficiency of 3-Phase induction motor.	K4
CO5	Pre-determine the regulation of an alternator by synchronous impedance method.	K5
CO6	Control the speed of dc shunt motor using Armature voltage and Field flux control methods.	K3
CO7	Draw the characteristics of PN junction diode & transistor.	K2
CO8	Determine the ripple factor of half wave & full wave rectifiers.	K5
CO9	Analyze the frequency response of to find the bandwidth of CE amplifier.	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	0	1	0	0	0	0	2	0	0	1	0	0
CO2	2	2	1	1	0	0	0	0	2	0	0	1	1	1
CO3	2	2	1	1	0	0	0	0	2	0	0	1	0	0
CO4	2	2	1	1	0	0	0	0	2	0	0	1	1	1
CO5	2	2	1	1	0	0	0	0	2	0	0	1	0	0
CO6	2	1	1	1	0	0	0	0	2	0	0	1	0	0
CO7	2	2	0	1	0	0	0	0	2	0	0	1	0	0
CO8	2	0	0	1	0	0	0	0	2	0	0	1	0	0
CO9	2	1	0	1	0	0	0	0	2	0	0	1	0	0

LIST OF EXPERIMENTS:	
Section A: Electrical Engineering(Any 6 of the following experiments are to be conducted)	
Experiment 1	Measurement of voltage, current and Power in Star and Delta Connected loads.
Experiment 2	Magnetization characteristics of DC Shunt Generator.
Experiment 3	Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
Experiment 4	Speed control of D.C. Shunt motor by a) Armature Voltage control b) Field control method.
Experiment 5	OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).
Experiment 6	Load Test on Single Phase Transformer.
Experiment 7	Brake test on 3-phase Induction motor (determination of performance characteristics)
Experiment 8	Regulation of alternator by Synchronous impedance method.
Section B: Basic Electronics(Any 4 of the following experiments are to be conducted)	
Experiment 1	PN junction diode characteristics a) Forward bias b) Reverse bias
Experiment 2	Transistor CE characteristics (input and output)
Experiment 3	Half wave rectifier with and without filters.
Experiment 4	Full wave rectifier with and without filters.
Experiment 5	CE amplifiers.
Experiment 6	OP- amp applications (integrator and differentiator).

References – Lab Manuals will be provided

II Year I Semester
COMPUTER AIDED ENGINEERING DRAWING PRACTICE

Course Category	Professional Core	**Course Code**	19ME2L03
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Exposure to Engineering Drawing	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To enhance the skills in drawing of projections of solids.
2	To impart the knowledge of sectioning and development of surfaces of solids.
3	To learn the Interpenetration of solids and also methods of Perspective views.
4	To introduce various commands in AutoCAD and to create 2D wire frame models.
5	To create 3D wire frame models and geometrical model of simple solids and machine parts.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Draw the auxiliary projections of the various types of solids.	K3
CO2	Develop the sections of solids.	K6
CO3	Create perspective views of a given 3D object/part.	K6
CO4	Understand the AutoCAD commands.	K2
CO5	Create 3D views using AutoCAD.	K6

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	1	2	-	3	-	3
CO2	3	2	2	-	-	-	-	-	1	2	-	3	-	3
CO3	3	2	2	-	-	-	-	-	1	2	-	3	-	3
CO4	3	2	2	-	3	-	-	-	1	2	-	3	-	3
CO5	3	2	2	-	3	-	-	-	1	2	-	3	-	3

COURSE CONTENT

UNIT I

Projections of Solids: Projections of Regular Solids - Auxiliary Views.

UNIT II

Sections of Solids: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views.

Development of Solids: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone and their parts.

UNIT III

Interpenetration of Right Regular Solids: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone.

Perspective Projections: Perspective View: Points, Lines, Plane Figures and Simple Solids, Vanishing Point Methods (General Method only).

UNIT IV

Introduction to Computer Aided Drafting: Generation of points, lines, curves, polygons, dimensioning. Types of modelling: object selection commands – edit, zoom, hatching, layers, pattern filling, utility commands, 2D wire frame modelling and other commands like view points and view ports, examples to exercise different options like save, restore, delete, joint, single option.

UNIT V

Computer Aided Solid Modelling: Isometric projections, orthographic projections of isometric projections, perspective views, modelling of simple solids, 3D wire frame modelling, Boolean operations.

TEXT BOOKS

1. Engineering Graphics, K.C. john, PHI Publications, 2009.
2. Engineering Drawing by N.D Bhatt, Charotar Publications, 53rd Edition.

REFERENCE BOOKS

1. Engineering Graphics using AutoCad, T Jeyapoovan, Vikas Publications, 7th Edition.
2. Engineering Drawing and Graphics+Auto CAD, K Venugopal, New age international publications, 4th Edition.
3. Engineering Drawing, RK Dhawan, S.Chand Publications, Revised Edition.
4. Engineering Drawing ,KL Narayana,Scitech Publications, 2013
5. Engineering Drawing – Basant Agarwal and C.M. Agarwal, Mc Graw Hill Education, 2nd Edition.

II Year I Semester
METALLURGY & MECHANICS OF SOLIDS LABORATORY

Course Category	Professional Core	**Course Code**	19ME3L05
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Exposure to Metallurgy & Mechanics Of Solids	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To impart practical exposure on the micro-structures of various materials and their hardness evaluation.
2	To study the behavior of materials under tension, compression, torsion, bending, shear and impact.
3	To study the behavior of springs under tension and compression.
COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	
CO1	Understand and differentiate microstructures of ferrous & non-ferrous alloys.
CO2	Determine Young's modulus of elasticity of bars, beams and springs subjected to various loads.
CO3	Analyze deflection and strength of springs.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	3	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	3	-
CO3	2	-	-	-	2	-	-	-	3	-	2	3	3	-

LIST OF EXPERIMENTS

A. Metallurgy:

1. Preparation and study of the Microstructure of Al.
2. Preparation and study of the Microstructure of Cu.
3. Preparation and Study of the Microstructure of Gray Cast-iron.
4. Preparation and Study of the Microstructure of Stainless steel.
5. Preparation and Study of the Microstructure of Brass.
6. Preparation and Study of the Microstructure Malleable Cast Iron.
7. To find the hardness of ferrous/ Non-ferrous materials.

B. Mechanics of Solids:

1. Direct Tension test on Universal Testing Machine (UTM).
2. Compression Test on wood on Universal Testing Machine (UTM).
3. (a) Bending test on simply supported beam.
   (i)Mild steel. (ii) Wood.
   (b) Bending test on cantilever beam made of Mild Steel/Aluminum/Brass/Stainless steel.
4. Torsion test.
5. Hardness test.
   (a) Brinell's hardness test.
   (b) Rockwell hardness test.
6. Test on springs.
   (a) Tension.
   (b) Compression.
7. Impact test.
   (a) Charpy.
   (b) Izod.

Additional Experiments:

1. Double shear test on Universal testing machine.
2. Punch shear test.

Note: Any 6 experiments from each section A and B

II Year I Semester
PROFESSIONAL ETHICS AND HUMAN VALUES
(Common to all branches)

Course Category	Humanities including Management	**Course Code**	19HM3T07
Course Type	Theory	**L-T-P-C**	2 -0 -0-0
Prerequisites		**Total Marks(Internal assessment)**	100

COURSE OUTCOMES		**Cognitive Level**
On successful completion of the course, the student will be able to		
CO 1	Understand different concepts in Professional Ethics and Human Values.	K2
CO 2	Apply ethical principles to resolve the problems that arise in work place.	K3
CO 3	Make use of Engineers rights to fulfill their responsibilities.	K3
CO 4	Understand the responsibility of an engineer in designing safety.	K2
CO 5	Analyze the social media accounts in order to create and maintain a positive digital footprint.	K4

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	2	-	-	3	2	3	-	2	-	1	-	-
CO2	-	-	2	-	-	2	2	3	-	1	-	2	-	-
CO3	-	-	2	-	-	3	2	3	-	2	-	1	-	-
CO4	-	-	2	-	-	3	2	3	-	2	-	1	-	-
CO5	-	-	2	-	-	2	2	3	-	1	-	1	-	-

COURSE CONTENT:

UNIT - I
Professional Ethics and Human values:
Ethics -History of Ethics-Types of Ethics, Professional Ethics and its forms - Morals, Values – Integrity –Civic Virtue –Respect for others – Living Peacefully – Caring – Sharing – Honesty –Courage – Value time –Co-operation – Loyalty- Collegiality-Commitment – Empathy – Self-confidence – Spirituality- Character.

UNIT - II
Engineering & Organization Ethics:
Engineering Ethics-Meaning & Purpose of Engineering Ethics- Consensus and Controversy –Work Place Ethics and Business Ethics –Ethics in HRM, Finance & Marketing – Ethical Theories-Meaning & Uses of Ethical Theories-Theories of moral Development-Kohlberg's Theory – Gilligan's Argument –Heinz's Dilemma.

UNIT - III
Engineers Responsibilities and Rights:
Key Characteristics of Engineering Professionals – Professional Roles to be played by an Engineer - Ethical egoism-

Collective bargaining-Confidentiality- Acceptance of Bribes/Gifts when is a Gift and a Bribe-examples of Gifts v/s Bribes-Whistle Blowing and its types-when should it be attempted-preventing whistle blowing.

UNIT - IV

Engineers' Responsibility for Safety and Risk:

Concept of Safety-Types of Safety, Risk-Types of Risks, Voluntary v/s Involuntary Risk- Short term v/s Long term Consequences- Expected Probability- Reversible Effects- Threshold Levels for Risk- Delayed v/s Immediate Risk-Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.

UNIT - V

Ethical issues in Social Media:

Social Media- Various Social Media Platforms: Google, Facebook, YouTube, Instagram -Social Media set-up and Uses-Ethical use of Social media-Effects of Social Media on Public- Social Media (vs) News- Social Media Fame and Reputation-Trolling, Harassing, and Hating on Social Media-Legal Aspects of Social Media.

REFERENCES :

1. "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and V.S.SenthilKumar- PHI Learning Pvt. Ltd-2009.
2. "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana- Maruthi Publications.
3. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- Laxmi Publications
4. "Professional Ethics and Human Values" by Prof.D.R.Kiran-
5. "Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication
6. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger -Tata McGraw- Hill -2003
7. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.

Web Resources:

1. https://study.com/academy/lesson/ethical-issues-in-internet-social-media-marketing.html
2. https://www.tutorialspoint.com/engineering_ethics/engineering_ethics_rights_of_engineers
3. https://link.springer.com/article/10.1007/s11948-997-0039-x

II Year II Semester
KINEMATICS OF MACHINERY

Course Category	Professional Core	**Course Code**	19ME4T09
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Mechanics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand different mechanisms and their motion constraints.
2	To study planar and spatial mechanisms.
3	To determine velocity and acceleration of different parts in a given mechanism by using graphical as well as analytical techniques.
4	To generate different cam profiles and study the transmission of power through belt drives.
5	To understand the concepts of gears and gears trains.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Illustrate the concepts of different mechanisms their motion constraints.	K2
CO2	Develop straight line motion mechanisms and steering gear mechanisms.	K3
CO3	Determine the kinematic analysis of simple mechanisms.	K5
CO4	Design cam profiles based on the prescribed follower motion and perform kinematic analysis on cams with specified contours.	K6
CO5	Illustrate gear terminology, gear types and analyze gear trains.	K4

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	3	-	-	2	-	-	-	2	3	1	1
CO2	3	3	1	3	-	-	-	-	2	1	2	3	1	-
CO3	3	3	2	3	-	-	-	-	-	2	2	3	2	1
CO4	3	2	3	2	-	-	-	-	-	2	1	3	1	1
CO5	3	3	3	3	-	-	2	-	-	2	2	3	1	-

COURSE CONTENT

UNIT I

Mechanisms and Machines: Introduction: Mechanism and machine; Rigid and resistant bodies; Link; Kinematic pair; Degrees of freedom; Classification of kinematic pairs; Kinematic chain; Linkage, mechanism and structure; Mobility of mechanisms. Application of Kutzbach Criterion to Plane Mechanisms. Grubler's Criterion for Plane Mechanisms. Grashof's law.

Inversions of Mechanisms: The four-bar chain; single and double slider crank chains.

UNIT II

Mechanism with Lower Pairs: Pantograph - straight line motion mechanisms - exact straight-line motion mechanisms- Peaucellier mechanism, Approximate straight-line motion mechanisms Watt mechanism. Condition for

correct steering- Davis & Ackerman's steering gear mechanisms.
Hooke's Joint: Ratio of shaft velocities - maximum and minimum speed of driven shaft - condition for equal speeds - Angular acceleration of driven shaft - Double Hooke's joint.

UNIT III
Velocity Analysis: Relative velocity method - velocity of point on a link- application of relative velocity method to simple mechanisms - rubbing velocity of a joint - Instantaneous center method - body centrode and space centrode - velocity of point on a link by Instantaneous center method, location of Instantaneous center - three centers in line theorem and its application for simple mechanisms.
Acceleration Analysis: Acceleration diagrams of a link- acceleration diagrams for simple mechanisms- coriolis component of acceleration - acceleration diagram for slotted lever quick return mechanism.

UNIT IV
Cams: Classification of followers and cams -terms used in radial cams - displacement, velocity and acceleration diagrams when the follower moves with uniform velocity, uniform acceleration and retardation, simple harmonic motion -construction of cam profiles.
Belt Drives: Introduction, Belt and rope drives, selection of belt drive- types of belt drives, V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt.

UNIT V
Toothed Gearing: Classification of toothed wheels - terms used in gears - law of gearing - velocity of sliding of teeth - forms of teeth - Cycloidal and involute teeth- length of path of contact-arc of contact-contact ratio- interference in involute teeth - minimum number of teeth to avoid interference.

Gear Trains: Simple, compound and reverted gear trains - epicyclic gear train - velocity ratio of epicyclic gear train - sun and planet wheels - torques in epicyclic gear train -Differential of an automobile.

TEXT BOOKS

1. Theory of Machines, S. S. Rattan, McGraw-Hill Publications, 3rd Edition.
2. Theory of Machines, Thomas Bevan, CBS Publishers & Distributors, 3rd Edition.

REFERENCE BOOKS

1. Theory of Machines and Mechanisms, Shigley J. E. and John Joseph Uicker, Oxford University Press, 3rd Edition.
2. Theory of Machines, R.K. Bansal & J.S. Brar, Laxmi publications (P) LTD, 5th Edition.
3. Theory of Machines, Sadhu Singh , Pearson, 3rd Edition.
4. Mechanism and Machine Theory, J. S. Rao and R. V. Dukkipati, New Age International, 2nd Edition.
5. Theory of Mechanisms and Machines, A Ghosh & A K Malik, 3rd Edition, East West Press.

WEB RESOURCES

1. www.mekanizmalar.com
2. www.museum.kyoto-u. ac.jp
3. Makezine.com
4. https://nptel.ac.in/courses/Webcourse-contents/IITDelhi/Kinematics%20of%20Machine/site/basic_kinematics/basickinematics08.htm
5. https://nptel.ac.in/courses/112105236/21
6. https://nptel.ac.in/courses/112105236/34
7. https://nptel.ac.in/courses/112104121/ 5. https://nptel.ac.in/courses/112106137/pdf/2_1.pdf.

II Year II Semester
APPLIED THERMODYNAMICS

Course Category	Professional Core	**Course Code**	19ME4T10
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Thermodynamics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand the fundamental components, performance evaluation and improve efficiency of steam power plant cycle.
2	To study the various types of boilers and their performance evaluation.
3	To study the performance of nozzle and condensers under various conditions.
4	To understand various types of steam turbines and their performance evaluation.
5	To study the various components of gas power plant cycle, performance evaluation and methods to improve the efficiency.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain steam power plant cycle to improve the performance by using different methods.	K5
CO2	Demonstrate the working of various boilers and their performance.	K2
CO3	Analyze steam nozzle for maximum discharge and condenser for better efficiency.	K4
CO4	Analyze the performance of steam turbines.	K4
CO5	Explain Gas turbine cycle to improve the performance by using different methods.	K5

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	-	-	2	2	-	-	-	-	2	3	-
CO2	3	3	2	-	-	2	2	-	-	-	-	2	3	-
CO3	3	3	3	-	-	2	2	-	-	-	-	2	3	-
CO4	3	3	3	-	-	2	2	-	-	-	-	2	3	-
CO5	3	3	2	-	-	2	2	-	-	-	-	2	3	-

COURSE CONTENT

UNIT I

Basic Concepts: Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating.

UNIT II

Boilers: Classification – working principles of L.P & H.P boilers with sketches – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – draught, classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.

UNIT III

Steam Nozzles: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow, its effects, degree of super saturation and degree of under cooling - Wilson line.

Steam Condensers: Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump- cooling water requirement.

UNIT IV

Steam Turbines: Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency.

Reaction Turbine: Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.

UNIT V

Gas Turbines: Simple gas turbine plant – ideal cycle, essential components – parameters of performance – actual cycle – regeneration, inter cooling and reheating –closed and semi-closed cycles – merits and demerits, types of combustion chambers.

TEXT BOOKS

1. Applied Thermodynamics by Eastop & McConkoy, Pearson Education, 5th Edition.
2. Thermodynamics and Heat Engines, Volume 2 ,R.Yadav, Central book depot, 3rd Edition.

REFERENCE BOOKS

1. Thermal Engineering, M.L.Marthur & Mehta, Jain bros, 5th Edition.
2. Heat Engineering, V.P Vasandani and D.S Kumar, Metropolitan Book Company, New Delhi, 3rd Edition.
3. Applied Thermodynamics, R Yadav, International publishers, 6th Edition.
4. Applied Thermodynamics, D.S.Kumar, S.K.Kotaria Publications, 2nd Edition.
5. Gas Turbines, V.Ganesan , Tata Mcgraw-Hill, 3rd Edition.

WEB RESOURCES

1. http://nptel.ac.in/courses/112106133/
2. http://nptel.ac.in/courses/112106133/3
3. http://nptel.ac.in/courses/112106133/13
4. http://nptel.ac.in/courses/112106133/14
5. http://nptel.ac.in/courses/112106133/16

Note: Use of steam tables and Mollier Chart is allowed.

II Year II Semester
MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

Course Category	Humanities including Management	**Course Code**	19HM4T01
Course Type	Theory	**L-T-P-C**	3 -0 -0-3
Prerequisites		**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OUTCOMES		**Cognitive Level**
On successful completion of the course, the student will be able to		
CO 1	Make use of the concepts of managerial economics and demand in managerial decision making and predicting demand for goods and services	K3
CO 2	Assess the functional relation among production, cost of production, cost concepts and Break-Even Analysis.	K5
CO 3	Classify market structures as perfect and imperfect markets for price and output decisions	K2
CO 4	Appraise the forms of business organizations and trade cycles in economic growth.	K5
CO 5	Apply accounting and capital budgeting techniques in financial decision making	K3

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	1	-	-	-	-	-	-	-	-	3	-	-	-
CO3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	-	3	-	-	-	-	-	-	-	-	1	-	-	-

COURSE CONTENT :

UNIT – I
Introduction to Managerial Economics and demand Analysis: Definition of Managerial Economics and Scope-Managerial Economics and its relation with other subjects-Basic Economic Tools used in Managerial Economics-Concepts of Demand-Types-Determinants-Law of Demand its Exceptions-Elasticity of Demand-Types and Measurement- Law of Supply -Demand forecasting and Methods of demand forecasting.

UNIT – II
Production and Cost Analysis: Production function- Law of Variable proportions- Iso-quants and Isocosts-Laws of Returns to Scale-Cobb-Douglas Production function-Economies of Scale-Cost Concepts- Fixed vs Variable Costs-Out of Pocket Costs vs Imputed Costs-Cost Volume Profit analysis-Determination of Break-Even Point (Simple Problems).

UNIT – III

Introduction to Markets: Market Structures: Perfect Competition, Monopoly, Monopolistic and Oligopoly – Features – Price and Output Determination.

Theories of the Firm & Pricing Policies: Managerial Theories of firm: Marris and Williamson's models – Methods of Pricing: Limit Pricing, Market Skimming Pricing, Internet Pricing: Flat Rate Pricing, Usage sensitive, Transaction based pricing, Priority Pricing.

UNIT – IV

Types of Business Organization and Business Cycles: Features and Evaluation of Sole Trader – Partnership – Joint Stock Company – State/Public Enterprises and their forms – Business Cycles – Meaning and Features – Phases of Business Cycles.

UNIT – V

Introduction to Accounting and Capital Budgeting: Introduction to Double Entry Systems-Journal-Ledger-Trail Balance - Preparation of Financial Statements

Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Need for Capital Budgeting-Techniques of Capital Budgeting-Traditional and Modern Methods.

TEXTBOOKS:

1. Dr. B. Kuberudu and Dr. T. V. Ramana: Managerial Economics & Financial Analysis, Himalaya Publishing House 2011.
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: 'Managerial Economics and Financial Analysis', Cengage Publications, New Delhi – 2011
3.. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2011

REFERENCE BOOKS :

1. V. Maheswari: Managerial Economics, Sultan Chand.
2. Suma Damodaran: Managerial Economics, Oxford 2011.
3. Prof. J.V.PrabhakaraRao, Prof. P. Venkatarao. 'Managerial Economics and Financial Analysis', Ravindra Publication.
4. Vanitha Agarwal: Managerial Economics, Pearson Publications 2011.
5. Sanjay Dhameja: Financial Accounting for Managers, Pearson.
6. Maheswari: Financial Accounting, Vikas Publications. 7. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2012

WEB RESOURCES:

1. https://economictimes.indiatimes.com/definition/law-of-supply
2. https://sites.google.com/site/economicsbasics/managerial-theories-of-the-firm
3. https://www.managementstudyguide.com/capitalization.htm

II Year II Semester
DESIGN OF MACHINE MEMBERS –I

Course Category	Professional Core	**Course Code**	19ME4T11
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Engineering Mechanics, Mechanics of Solids, Material Science.	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand the fundamental design concepts and apply the theories of failures to evaluate the strength of the machine elements.
2	To learn strength of the machine components subjected to static and variable loads by using different failure theories.
3	To study the basic principles for design of machine elements such as temporary and permanent joints.
4	To understand various joints subjected to combined loading for shaft design.
5	To study various shaft couplings subjected to torsion.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the design procedure and find the stresses in machine components.	K2
CO2	Apply the loads on machine members and analyze the variable stresses to ensure safe design.	K3
CO3	Determine and analyze the stresses in temporary and permanent joints under various loading conditions.	K5
CO4	Determine and analyze the stresses in different shaft joints along with keys under various loading conditions.	K5
CO5	Design and analyze the shaft couplings for various engineering applications.	K6

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1	-	-	-	-	-	-	1	1
CO2	2	1	1	2	1	2	-	-	-	-	-	-	2	-
CO3	2	1	2	1	3	2	-	-	-	-	-	1	1	2
CO4	2	2	1	2	3	2	-	-	-	-	-	1	2	1
CO5	2	1	2	2	3	2	-	-	-	-	-	1	2	1

COURSE CONTENT

UNIT I

INTRODUCTION: General considerations in the design of Engineering Materials and their properties – selection – Manufacturing consideration in design, tolerances and fits –BIS codes of steels.

STRESSES IN MACHINE MEMBERS: Simple stresses – combined stresses – torsional and bending stresses – impact stresses – stress strain relation – various theories of failure – factor of safety – design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness.

UNIT II

STRENGTH OF MACHINE ELEMENTS: Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – goodman's line – soderberg's line – modified goodman's line.

UNIT III

RIVETED & WELDED JOINTS - Types of riveted heads and riveted joints- Lap Joint – Butt joint–Design of riveted joints with initial stresses - Strength of parallel fillet and Transverse fillet welded joints- Welded joint: Eccentric loading.

BOLTED JOINTS – Design of bolts with pre-stresses – design of joints under eccentric loading – locking devices – both of uniform strength, different seals, Caulking and Fullering.

UNIT IV

KEYS, COTTERS AND KNUCKLE JOINTS: Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints- knuckle joints.

SHAFTS: Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes – BIS code. Use of internal and external circlips, gaskets and seals (stationary & rotary).

UNIT V

SHAFT COUPLING: Types of shaft couplings-Rigid couplings – muff, split muff and flange couplings, flexible couplings – flange coupling (modified).

TEXT BOOKS

1. Design of Machine Elements / V.M. Faires/McMillan publisher, 4th edition.
2. Machine Design/V.Bandari/ TMH Publishers, 3rd edition.

REFERENCE BOOKS

1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education, 2nd Edition.
2. Mechanical Engineering Design by Shigley, Mc Graw Hill 10th Edition.
3. Elements of Machine Design N.C.Pandya, C.S.Shaw, Charotar Publishing House Pvt Ltd, 15th Edition.
4. Machine Design by Schaum's, Mc Graw Hill series, 1st Edition.
5. Machine Design data book by B.B. Bandari, Mc Graw Hill, 1st Edition.

WEB RESOURCES

1. http://nptel.ac.in/courses/112105124/5
2. http://nptel.ac.in/courses/112105124/7
3. http://nptel.ac.in/courses/112105124/20
4. http://nptel.ac.in/courses/112105124/35
5. http://nptel.ac.in/courses/112105124/13

II Year II Semester
METAL CUTTING & MACHINE TOOLS

Course Category	Professional Core	**Course Code**	19ME4T12
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Exposure to Metallurgy & Material Science, Production Technology.	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
The students are to be exposed to the concepts of	
1	Tool geometry and material removal processes.
2	Material removal process with different tools using Lathe Machines.
3	The knowledge in manufacturing applications through various machine tools.
4	Principles of metal cutting to practical applications through milling machines.
5	Finishing methods and holding devices.

COURSE OUTCOMES		
The student will be able to:		**Cognitive Level***
CO1	Analyze the fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.	k4
CO2	Understand the fundamentals and principles of metal cutting to practical applications through Lathe machine.	k2
CO3	Apply the The knowledge in manufacturing applications through various machine tools.	k3
CO4	Understand the Principles of metal cutting to practical applications through milling machines.	k2
CO5	Analyze Finishing methods and holding devices.	k4

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	3	2	-	-	3	1	1	3	3	1
CO2	3	3	3	1	3	3	-	-	3	1	3	3	3	2
CO3	3	3	3	1	3	3	-	-	3	1	3	3	3	2
CO4	3	3	3	1	3	3	-	-	3	1	3	3	3	2
CO5	3	3	3	1	3	3	-	-	3	1	3	3	3	2

COURSE CONTENT

UNIT I

FUNDAMENTALS OF MACHINING: Elementary treatment of metal cutting theory – element of cutting process – geometry of single point cutting tool, tool angles, chip formation and types of chips-built up edge and its effects chip breakers, mechanics of orthogonal cutting – Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, tool wear, machinability, economics of machining, coolants, tool materials and properties.

UNIT II

LATHE: Engine lathe – principle of working, specification of lathe – types of lathe – work holders , tool holders – box tools taper turning, thread turning – for lathes and attachments, constructional features of speed gear box and feed gear box. Turret and capstan lathes – collet chucks – other work holders – tool holding devices – box and tool layout. Principal features of automatic lathes – classification – single spindle and multi-spindle automatic lathes.

UNIT III

SHAPING, SLOTTING AND PLANING MACHINES: Principles of working – principal parts – specifications, operations performed, quick return mechanisms and table feed mechanisms, Machining time calculations.

MILLING MACHINES: Principles of working – specifications – classification of Milling Machines and Principle features, machining operations, types of cutters, geometry of milling cutters – methods of indexing, accessories to milling machines.

UNIT IV

DRILLING & BORING MACHINES: Principles of working, specifications, types, operations performed –types of drills – Boring Machines

FINISHING PROCESSES: Theory of grinding – classification of grinding machines, cylindrical and surface grinding machines, tool and cutter grinding machines, different types of abrasives, bonds, specification and selection of a grinding wheel. Lapping, Honing & Broaching operations, comparison to grinding.

UNIT V

JIGS & FIXTURES: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location and clamping, types of clamping & work holding devices, typical examples of jigs and fixtures.

CNC MACHINE TOOLS: CNC Machines, working principle, classification, constructional features of CNC machines.

TEXT BOOKS

1. Manufacturing Technology- Volume-II/P.N Rao/Tata McGraw Hill/4th edition, 2018.
2. A course in Workshop Technology – B.S.RaghuVamshi – Volume II,Dhanapat Rai & Co.,10th edition, 2009.

REFERENCE BOOKS

1. A Text book of Production Engineering(Manufacturing Proceeses)-P.C.Sharma, S.Chand & Company Ltd,8th revised edition,2014.
2. Elements of workshop technology volume-II machine tools by S.K.Hajra choudary, S.K.Bose, A.K.Hajra choudary, Media promoters & publishers pvt ltd.,13th edition, 2010.
3. A text book of Manufacturing Technology (manufacturing Processes) by R.K.Rajput Lakshmi Publications(p) Ltd.,1st edition,2007.
4. Metal cutting Principles by Milton Clayton Shaw,3rd edition,1960.
5. Production Technology by H.M.T. (Hindustan Machine Tools), Tata McGraw-Hill private company limited, 28th edition,2008.

WEB RESOURCES

1. https://nptel.ac.in/courses/112105126/1
2. https://nptel.ac.in/courses/112105126/2
3. https://nptel.ac.in/courses/112105126/11
4. https://nptel.ac.in/courses/112105126/23
5. https://nptel.ac.in/courses/112105127/
6. https://nptel.ac.in/courses/112105127/33
7. https://nptel.ac.in/courses/112105127/30

II Year II Semester
MACHINE DRAWING

Course Category	Professional Core	**Course Code**	19ME4T13
Course Type	Theory	**L-T-P-C**	1-0-4-3
Prerequisites	Exposure to Engineering Drawing	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To provide basic understanding of Conventional representation, sections, joints, simple mechanical parts.
2	The student will be able to draw the assembly from the individual part drawing.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level***
CO1	Illustrate different kinds of materials and mechanical components conventionally.	k2
CO2	Model the assembly drawing using part drawings.	k3

*k1- Remembering, k2- Understanding, k3- Applying, k4- Analyzing, k5- Evaluating, k6- Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	2	-	1	-	-	-	1	2	-	-	1	-
CO2	2	-	-	-	2	-	-	-	1	2	-	-	1	-

COURSE CONTENT

PART A
Conventional representation of materials and components:

- Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs, symbols for weldments.
- Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.
- Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
- Keys, Cotter joints and knuckle joint.
- Riveted joints for plates.
- Shaft coupling, spigot and socket pipe joint.
- Journal, pivot and collar Pedestal Bearing (Plummer Block) and foot step bearings.

PART B

Assembly Drawings:

Drawings of assembled views for the part drawings of the following, using conventions and easy drawing proportions.

Engine parts: Stuffing box, Cross head, Eccentric, Petrol Engine connecting rod and Piston.

Other machine parts: Screws jack, Machine Vice, Plummer block and Tool post.

Valves: Steam stop valve, Spring loaded safety valve, Feed check valve and air cock.

TEXT BOOKS

1. Machine Drawing –K.L. Narayana, P.Kannaiah & K. Venkata Reddy / New Age/ Publishers, 6th Edition.
2. Machine Drawing: Includes Auto CAD – Ajeet Singh/McGraw Hill Education, 2nd Edition.

REFERENCE BOOKS

1. Machine Drawing by N.D.Bhatt, V.M. Panchal Charotar Publications, 50th Edition.
2. Machine Drawing, O.P Jahkar, Amit Mathur, Khanna Publishing House, 1st Edition.
3. Machine Drawing, S.Gill, Katson Books,2017.
4. Machine Drawing, KC John, PHI,2009.
5. Fundamentals of Machine Drawing, Sadhu Sign , PL Sah, PHI,2nd Edition.

WEB RESOURCES

1. http://gt3.bme.hu/wp-content/uploads/2016/02/Narayana-Machine_Drawing.pdf

Note: First angle projection to be adopted. The student should be able to provide working drawings of actual parts

II Year II Semester
FLUID MECHANICS & HYDRAULIC MACHINERY LABORATORY

Course Category	Professional Core	**Course Code**	19ME4L06
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Exposure to Fluid Mechanics and Hydraulic Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVE

To impart practical exposure on the performance evaluation methods of various flow measuring equipment, hydraulic turbines and pumps.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:

CO1	Apply the fundamental principles of fluid mechanics, calculations involving basic flow measuring devices like venture meter, Orifice meter and major and minor losses of fluid flow through the pipes.
CO2	Estimate the optimum efficiency of a given pump under different load and (or) speed conditions and to analyze the trends depicted by characteristic curves obtained from the experiments.
CO3	Estimate the optimum efficiency of a given turbine under different load and (or) speed conditions and to analyze the trends depicted by characteristic curves obtained from the experiments.

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	3	-	-	3	3	-	-	-	-	-	3	-
CO2	3	-	-	2	-	-	-	-	-	-	-	-	3	-
CO3	-	3	3	-	-	3	2	-	-	-	-	-	3	-

LIST OF EXPERIMENTS

1. Calibration of Venturimeter.
2. Calibration of Orificemeter.
3. Determination of Friction factor for a given pipe line.
4. Losses in pipe fittings.
5. Impact of jet on vanes.
6. Performance test on Pelton wheel-constant head.
7. Performance test on Pelton wheel-constant speed.
8. Performance test on Francis turbine-constant head.
9. Performance test on Francis turbine-constant speed.
10. Performance test on Single stage centrifugal pump.
11. Performance test on Multi stage centrifugal pump.
12. Performance test on Reciprocating pump.

Note: Any 10 of the above 12 experiments are to be conducted.

II Year II semester
PRODUCTION TECHNOLOGY LABORATORY

Course Category	Professional Core	**Course Code**	19ME4L07
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Exposure to Production Technology	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVE	
To impart hands-on practical exposure on manufacturing processes and equipment.	
COURSE OUTCOMES	
Upon successful completion of the course, the student will be able to:	
CO1	Make the pattern, mould and casting.
CO2	Do the arc welding, spot welding and brazing, injection and blow molding.
CO3	Do the metal forming and powder metallurgy test.

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2	-	-	-	-	1	-	1	-	3	-
CO2	3	3	3	2	-	-	-	-	1	-	1	-	3	-
CO3	3	3	3	2	-	-	-	-	1	-	1	-	3	-

LIST OF EXPERIMENTS

A. Metal Casting Process:
1. Pattern making.
2. Sand testing - for strength and permeability.
3. Mould preparation.
4. Melting and Casting.
5. Sieve Analysis.

B. Welding:
1. Manual metal arc welding - Lap & Butt Joints.
2. Resistance Spot Welding.
3. Brazing and soldering.
4. Gas cutting.
5. TIG/MIG Welding.
6. Gas welding.

C. Metal Forming and Powder Metallurgy:
1. Blanking & Piercing operations and study of simple, compound and progressive dies.
2. Deep drawing and extrusion operations.
3. Bending and other operations.
4. Basic powder compaction and sintering.

D. Processing of Plastics:
1. Injection & Blow Moulding.

Note: Total 10 experiments should be conducted from A, B, C & D.

II Year II semester
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

Course Category	Humanities including Management	**Course Code**	19HM4T06
Course Type	Theory	**L-T-P-C**	2 -0 -0-0
Prerequisites		**Total Marks(Internal Assessment)**	100

COURSE OUTCOMES		**Cognitive Level**
On successful completion of the course, the student will be able to		
CO 1	Understand the significance of Indian Traditional Knowledge.	K2
CO 2	Classify the Indian Traditional Knowledge	K4
CO 3	Compare Modern Science with Indian Traditional Knowledge system.	K5
CO 4	Analyze the role of Government in protecting the Traditional Knowledge	K4
CO 5	Understand the impact of Philosophical tradition on Indian Knowledge System.	K2

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	1	2	-	-	3	-	1	-	2	-	-	-	-
CO2	-	-	2	-	-	2	-	2	-	-	-	-	-	-
CO3	-	-	2	-	-	3	-	1	1	2	2	1	-	-
CO4	-	-	2	-	-	2	-	2	-	-	-	-	-	-
CO5	-	-	1	-	-	3	-	1	-	3	-	1	-	-

COURSE CONTENT

UNIT I
Introduction to Traditional Knowledge: Define Traditional Knowledge- Nature and Characteristics- Scope and Importance- kinds of Traditional Knowledge- The historical impact of social change on Traditional Knowledge Systems- Value of Traditional knowledge in global economy.

UNIT II
Basic structure of Indian Knowledge System: Astadash Vidya- 4 Ved - 4 Upaved (Ayurved,Dhanurved,GandharvaVed&SthapthyaAdi),6vedanga(Shisha,Kalppa,Nirukha,Vykaran,Jyothisha &Chand), 4upanga(Dharmashastra,Meemamsa,purana&Tharka Shastra).

UNIT III
Modern Science and Indian Knowledge System-Indigenous Knowledge, Characteristics- Yoga and Holistic Health care-cases studies.

UNIT IV

Protection of Traditional Knowledge: The need for protecting traditional knowledge -Significance of Traditional knowledge Protection-Role of government to harness Traditional Knowledge.

Unit V

Impact of Traditions: Philosophical Tradition (Sarvadarshan) Nyaya, Vyshepec, Sankhya, Yog, Meemamsa, Vedantha, Chavanka, Jain &Boudh - Indian Artistic Tradition - Chitra kala, Moorthi kala, Vasthu kala , Sthapthya, Sangeetha, NruthyaYevamSahithya

Reference Books :

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.
3. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya
4. Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan
5. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
6. Pramod Chandra, India Arts, Howard Univ. Press, 1983.
7. Krishna Chaitanya, Arts of India, Abhinav Publications, 1987.

Web Resources:

1. https://www.wipo.int/wipo_magazine/en/2017/01/article_0004.html
2. http://iks.iitgn.ac.in/wp-content/uploads/2016/01/Indian-Knowledge-Systems-Kapil-Kapoor.pdf
3. https://www.wipo.int/edocs/mdocs/tk/en/wipo_grtkf_ic_21/wipo_grtkf_ic_21_ref_facilitators_text.pdf

III Year I Semester
DYNAMICS OF MACHINERY

Course Category	Professional Core	**Course Code**	19ME5T14
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Kinematics of Machines	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand static and dynamic forces of planar mechanisms and flywheel design.
2	To know of friction on clutches, brakes and dynamometers.
3	To impart the knowledge on balancing of rotary and reciprocating masses.
4	To understand the effect of precession on the stability of moving vehicles and various types of governors used for controlling the speed of engines.
5	To equip knowledge on vibrations and their importance in design of machine structures.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze static and dynamic forces of planer mechanism and design of flywheel for regulating the speed of engine and machines.	K4
CO2	Apply the concept of friction in screw and nut, clutches, brakes and dynamometers.	K3
CO3	Understand the concept of balancing of rotating and reciprocating masses and analyze the undesirable effects of unbalanced forces of rotating and reciprocating masses resulting from prescribed motions.	K4
CO4	Apply the concept of gravity and centrifugal governors to control the speed of the engines and analyze the stabilization of sea vehicles, aircrafts and automobiles.	K4
CO5	Analyze the effect of vibration on beams and shafts with various load distributions.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	2	--	--	--	--	--	--	--	--	2	--
CO2	2	2	2	--	--	--	--	--	--	--	--	--	--	1
CO3	1	3	2	--	--	--	--	--	--	--	--	--	1	1
CO4	--	3	1	--	--	--	--	--	--	--	--	--	2	1
CO5	--	3	1	1	--	--	--	--	--	--	--	--	--	--

COURSE CONTENT

UNIT I
STATIC AND DYNAMIC FORCE ANALYSIS: Static and Dynamic Force analysis of Planar mechanisms, Inertia forces and D-Alembert's Principle, Dynamic force analysis of slider crank

mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design.

UNIT II

FRICTION, CLUTCHES, BRAKES AND DYNAMOMETER

Friction-Clutches: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis: lubricated surfaces, boundary friction, film lubrication. Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch.

Brakes and Dynamometers: Simple block brakes, internal expanding brake, band brake of vehicle. General description and operation of dynamometers: Prony, Rope brake, Epicyclic, Bevis Gibson and belt transmission.

UNIT III

BALANCING: Balancing of rotating masses – single and different planes, use analytical and graphical methods. Balancing of primary and secondary unbalanced forces of reciprocating masses, Effect of partial balancing of two-cylinder locomotives, variation of tractive force, swaying couple and hammer blow.

UNIT IV

MECHANISM FOR CONTROL:

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves.

Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

UNIT V

VIBRATIONS: Free Vibration of spring mass system –Natural frequency-types of damping –damped free vibration, Simple problems on forced damped vibration, Vibration Isolation & Transmissibility, Whirling of shafts, critical speeds, torsional vibration, two and three rotor systems.

TEXT BOOKS

1. Theory of Machines, S.S Rattan, Mc. Graw Hill, 2014.
2. Theory of machines, Khurmi, R, S. Chand & Co. Ltd., New Delhi 2005, 14th edition, 2005.

REFERENCE BOOKS

1. Mechanism and Machine Theory, JS Rao and RV Dukkipati, New Age Publications.
2. Theory of Machines, John J. Dicker, Jr., Gordon R. Pennock, Joseph E. Shigley, Oxford university press
3. Theory of Machines, Thomas Bevan, McGraw-Hill Science.

WEB RESOURCES

1. nptel.ac.in/courses/112104114/
2. nptel.ac.in/courses/112101096/
3. nptel.ac.in/syllabus/112104114/
4. www.nptelvideos.in/2012/12/dynamics-of-machines.html
5. freevideolectures.com › Mechanical › IIT Kanpur

III Year I Semester
DESIGN OF MACHINE MEMBERS –II

Course Category	Professional Core	**Course Code**	19ME5T15
Course Type	Theory	**L-T-P-C**	**3-0-0-3**
Prerequisites	Design of machine members-I and Kinematics of Machinery.	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To gain knowledge about various bearings and design procedure of journal, ball and roller bearings.
2	To learn about design and analysis of the engine parts such as cylinder, piston, connecting rod and crankshaft.
3	To impact knowledge on design and analysis of power screws and Stresses applied in different types of beams
4	Learn to design the mechanical systems for power transmission elements such as belts, chain drives and wire ropes.
5	To familiarize the various steps involved in the design procedure of spur and helical gears.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Identify suitable bearing based on the application of the loads and predict the life of the bearing.	K3
CO2	Design the engine parts such as cylinder, piston, connecting rod and crankshaft	K4
CO3	Design of power screws subjected to loading and stresses applied in different types of beams	K4
CO4	Analyze power transmission efficiencies through belts, chains, pulleys and wire ropes.	K4
CO5	Select the appropriate gear for the given operating conditions.	K3

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	3	1	--	--	--	3	--	--	--	--	1	--
CO2	2	2	3	1	--	--	--	3	--	--	--	--	1	--
CO3	2	2	3	2	--	--	--	3	--	--	--	--	1	--
CO4	2	1	3	2	--	--	--	3	--	--	--	--	1	--
CO5	2	1	3	2	--	--	--	3	--	--	--	--	1	--

COURSE CONTENT

UNIT I
BEARINGS: Classification of bearings, applications, types of journal bearings, lubrication, bearing modulus, full and partial bearings, clearance ratio, heat dissipation of bearings, bearing materials, design of journal bearing, ball and roller bearings, static loading of ball & roller bearings, bearing life.

UNIT II
ENGINE PARTS: IC Engine Construction, design of cylinder, cylinder block, piston, connecting rod. cranks and crank shafts - centre and over hung cranks.

UNIT III

DESIGN OF POWER SCREWS: Types of screws – Square, ACME, Buttress, design of screw, nut, and compound screw, design of lead screw and screw Jack.

Design of Curved Beams: Stresses in curved beams, Expression for radius of neutral axis for rectangular, circular, trapezoidal and T-Section, design of crane hooks and C –clamps.

UNIT IV

POWER TRANSMISSIONS SYSTEMS: Types of belts – flat, V-Vee type and Rope, materials, transmission of power by belt and rope drives, transmission efficiencies, design of belt, design of pulleys for belt, types of chains, types of chains drives and design of chain drive.

Wire Ropes: Construction, Designation, Stresses in wire ropes, rope sheaves and drums and design of wire rope.

UNIT V

GEAR DRIVES: Types of gears - Spur and Helical, nomenclature of gear, load concentration factor, dynamic load factor, surface compressive strength, bending strength, estimation of centre distance, module and face width, design of spur gear and helical gear, check for plastic deformation, check for dynamic and wear considerations.

TEXT BOOKS

1. Design of Machine Elements by V.Bandari/ Tata McGraw Hill education.
2. Machine Design by T.V. Sundararajamoorthy & N. Shanmugam/ Anuradha Publications.
3. A Text Book of Machine Design by S.Md.Jalaludeen/ Anuradha Publications.

DATA BOOKS (Allowed in Examinations)

1. Machine Design Data Book by S.Md.Jalaludeen/ Anuradha Publications.
2. Design Data Book by PSG College of Technology.

REFERENCE BOOKS

1. Mechanical Engineering Design by Shigley's / Richard Budynas & Keith Nisbett /Tata McGraw Hill education.
2. Machine design an Integrated Approach by Robert L. Norton/ Person Education Limited.
3. Machine design by R.S.Khurmi/ S.Chand.

WEB RESOURCES

1. http://nptel.ac.in/courses/112102015/28
2. http://nptel.ac.in/courses/112104203/31

III Year I Semester
OPERATIONS RESEARCH

Course Category	Professional core	**Course Code**	19ME7T16
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
To make the students learn about	
1	Applications of operations research through LPP.
2	Formulation of objective function through transportation and assignment problems.
3	How to sequence the jobs and machines while processing and Replacement of machine / equipment.
4	The applications of waiting line problems and operations research through DPP
5	Deterministic and stochastic models.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Formulate the objective function by linear programming problem and solution through various models.	K3
CO2	Evaluate optimal solutions to the objective function with the knowledge of transportation and assignment problems.	K3
CO3	Apply the sequencing of the jobs on a machine and items replacement**s**	K4
CO4	Apply the principle of dynamic programming and service rate.	K3
CO5	Apply the inventory models in balancing the stock and demand ratio for profits	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	3	-	-	-	-	-	3	-	3	1
CO2	3	3	3	1	3	-	-	-	-	-	3	-	3	1
CO3	3	3	3	1	3	-	-	-	-	-	3	-	3	1
CO4	3	3	3	2	3	-	-	-	-	-	3	-	3	2
CO5	3	3	3	1	3	-	-	-	-	-	3	-	3	2

COURSE CONTENT

UNIT I

INTRODUCTION: Development – definition– characteristics and phases – types of operation research models – applications.

ALLOCATION: Linear programming problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle

UNIT II

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy,

ASSIGNMENT PROBLEM – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

UNIT III

SEQUENCING – Introduction – flow –shop sequencing –*n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

UNIT IV

WAITING LINES: Introduction – single channel – poison arrivals –exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel poison arrivals.

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – shortest path problem – linear programming problem.

UNIT V

INVENTORY: Introduction – single item – deterministic models –purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

TEXT BOOKS

1. Operations Research / S.D.Sharma-Kedarnath

REFERENCE BOOKS

2. Operations Research / A.M.Natarajan, P. Balasubramani, A.Tamilarasi / Pearson Education.
3. Operations Research / R.Pannerselvam,PHI Publications.
4. Operations Research / Wagner/ PHI Publications.
5. Operations Research/S Kalavathy / Vikas Publishers
6. Operations Research / DS Cheema/University Science Press
7. Operations Research / Ravindran, Philips, Solberg / Wiley publishers.

WEB RESOURCES

1. http://www.nptelvideos.in/2012/12/fundamentals-of-operations-research.html

III Year I Semester
IC ENGINES AND TURBO MACHINERY

Course Category	Professional core	**Course Code**	19ME5T17
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Thermodynamics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Make the student to understand the affects of various losses that occurs in the actual engine operation and familiarize the student with the various engine systems along with their function and necessity.
2	To learn about normal combustion phenomenon and knocking in S.I. and C.I. Engines and to find the several engine operating parameters that affect the smooth operation of engine.
3	To learn S.I and C.I Engines performance and emission parameters.
4	To learn the various types of Turbo Machinery and their Concepts along with their various principles and Velocity Analysis.
5	To Understand and Analyze various concepts like work and efficiency of Axial Flow Turbine, Compressors and Centrifugal Compressors.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze various Thermal Cycles related to IC Engines	K3
CO2	Student will be able to apply various concepts like Knocking, Pre-Ignition to the studied Thermal Cycles of the IC Engines	K3
CO3	Calculate the efficiencies of the IC Engines based on the given input and output conditions and partial burning of the charge, its analysis and effect on the IC Engine.	K4
CO4	Student will be able to Classify Turbo Machinery and Demonstrate various principles and concepts related to them.	K4
CO5	Students will be able to apply the various concepts learned and analyze the various flow systems of the Turbo Machinery.	K4

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1	2	--	--	1	--	--	--	--	2	--
CO2	2	2	1	1	1	2	2	--	--	--	--	--	1	--
CO3	3	3	3	1	1	2	3	--	--	--	--	2	2	--
CO4	3	3	3	1	1	--	--	--	--	--	--	1	2	--
CO5	2	2	1	1	1	--	--	--	--	--	1	1	1	--

COURSE CONTENT

UNIT I

Air Standard Cycles; Actual Cycles and their comparison; Time Loss Factor; Heat Loss Factor; Exhaust Blow down-Loss due to Gas exchange process; Volumetric Efficiency of the various Air-Standard and Actual Cycles.

Classification of IC Engines and their Working principles; Valve and Port Timing Diagrams; Engine systems – Fuel; Carburetor; Fuel Injection System; Ignition-Definition, Systems; Cooling and Lubrication; principle of wankle engine; principles of supercharging and turbo charging; DTSI technology.

UNIT II

Combustion in S.I. Engines : Normal Combustion and abnormal combustion; Importance of flame speed and effect of engine variables; Type of Abnormal combustion, pre-ignition and knocking (explanation)

Combustion in C.I. Engines: Four stages of combustion; Delay period and its importance; Effect of engine variables; Diesel Knock; Need for air movement; suction; compression and combustion induced turbulence in Diesel Engines.

UNIT III

Measurement, Testing and Performance: Parameters of performance; Measurement of cylinder pressure; fuel consumption; air intake; exhaust gas composition; Brake power; Determination of frictional losses and indicated power; Performance test; Heat balance sheet

UNIT IV

Introduction: Classification of Turbo Machines; Second Law of Thermodynamics- Turbine/Compressor work and Nozzle/Diffuser work; Isentropic Flow- Energy Transfer; Efficiencies; Continuity, Bernoulli and Euler's Equations and Euler's flow through variable cross-sectional areas.

Principles of Turbo Machinery: Euler's equation of Energy Transfer; Vane Congruent Flow; Influence of Relative Circulation; Number and Thickness of Vanes on Velocity Triangles; Axial, Radial and Mixed Flow Machines; Similarity Laws.

UNIT V

Axial flow analysis: Concepts of Work and Velocity Triangles-Efficiencies, Thermodynamic analysis, Stage pressure rise and loading; Degree of Reaction for both Compressors and Turbines; 50% Reaction Turbine Stage.

Centrifugal Compressors- Types; Forward, Radial and Backward swept vanes- Velocity Triangles and Efficiencies; Blade Passage Design; Degree of Reaction; Slip Factor; Stanitz and Stodola's Formulae

TEXT BOOKS

1. I.C. Engines by V. GANESAN- TMH
2. Heat engines by Vasandani & Kumar- Metropolitan Book Co. Pvt. Ltd.
3. Turbines, Compressors and Fans by S. M. Yahya-McGraw Hill Publications

REFERENCE BOOKS

1. I.C. Engines - J.B. Heywood /Mc Graw HIll.
2. Thermal Engineering – R.S.Khurmi & J.S.Gupta- S.Chand Publ.
4. Principles of Turbo Machinery by R. K. Turton- Chapman & Hall Publications

WEB RESOURCES

1. http://nptel.ac.in/courses/112105123/
2. http://nptel.ac.in/courses/112108148/
3. http://nptel.ac.in/courses/112104113/
4. http://nptel.ac.in/courses/112104033/

III Year I Semester
AUTOMOBILE ENGINEERING

Course Category	Professional Elective	**Course Code**	19ME5T18
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	IC Engines and Turbo Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn functions of different components in Automobiles
2	To impart knowledge on Transmission systems and Steering Systems.
3	To impart the knowledge on ignition system & suspension systems.
4	To impart the knowledge of Braking system and Engine specification.
5	To understand the concept of safety and Engine emission control systems.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Understand the function of various components of automobile.	K2
CO2	Identify the merits and demerits of the various transmission and steering systems.	K2
CO3	Describe the concept of Ignition and Suspension systems.	K2
CO4	Explain the features of Braking system and Engine specification.	K4
CO5	Analyze the Engine emission control standards.	K4

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	2	2	-	-	-	-	-	2	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	1	-	2	2	-	-	-	-	-	2	1
CO5	2	2	1	-	-	-	2	-	-	-	-	1	3	-

COURSE CONTENT

UNIT I

INTRODUCTION: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction, oil filters, oil pumps, air filters, Fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps, Types of carburetor.

UNIT II

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toe-in, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism,

steering gears – types, steering linkages.

UNIT III

IGNITION SYSTEM: Function of an ignition system, auto transformer, contact breaker points, condenser and spark plug –electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

UNIT IV

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

ENGINE SPECIFICATION: Introduction-engine specifications with regard to power, speed, torque, no. of cylinders and arrangement.

UNIT V

SAFETY SYSTEMS: Introduction, safety systems - seat belt, air bags, bumper, anti lock brake system (ABS), wind shield, suspension sensors, traction control, mirrors, central locking and electric windows, speed control.

ENGINE EMISSION CONTROL: Introduction – types of pollutants, mechanism of formation, concentration measurement, methods of controlling-engine modification, exhaust gas treatment thermal and catalytic converters-use of alternative fuels for emission control – National and International pollution standards.

TEXT BOOKS

1. Automotive Mechanics / Heitner
2. Automobile Engineering / William Crouse, TMH Distributors .
3. Automobile Engineering- P.S Gill, S.K. Kataria& Sons, New Delhi.

REFERENCE BOOKS

1. Automotive Engines Theory and Servicing, James D. Halderman and Chase D. Mitchell Jr., Pearson education inc.
2. Automotive Engineering / Newton Steeds & Garrett.
3. Automotive Mechanics – Vol. 1 & Vol. 2 / Kripal Singh, standard publishers.

WEB RESOURCES

1. https://nptel.ac.in/courses/107/106/107106080/
2. http://gabook.cyou/file/nptel-automobile-engineering
3. https://nptel.ac.in/courses/107/106/107106088/

III Year I Semester
NANO TECHNOLOGY

Course Category	Professional Elective	**Course Code**	19ME5T19
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Engineering physics	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Students will learn	
1	Understand the basic scientific concepts of nano science.
2	Understand the properties of nano materials characterization of materials.
3	Understand the synthesis and fabrication.
4	Understand the characterization techniques
5	Understand the applications of nano technology in various science, engineering and technology fields.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		Cognitive Level
CO1	Define the essential concepts used in nanotechnology	K1
CO2	List out the material properties	K1
CO3	Explain the syntheses and fabrication	K2
CO4	Demonstrate the characterization techniques	K2
CO5	Recall applications in various fields	K1

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	3	1	2	1	-	-	-	-	-	1	1	1
CO2	2	-	-	1	2	-	-	-	-	-	-	-	2	-
CO3	2	-	3	2	1	-	-	-	-	-	-	-		-
CO4	3	2	3	2	1	-	-	-	-	-	-	-	2	1
CO5	2	1	3	2	2	-	-	-	-	-	-	-	1	2

COURSE CONTENT

UNIT I
INTRODUCTION: History of nano science, definition of nano meter, nano materials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure.

UNIT II
PROPERTIES OF MATERIALS: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto-electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

UNIT III
SYNTHESIS AND FABRICATION: Synthesis of bulk polycrystalline samples, growth of single crystals.

Synthesis techniques for preparation of nano particle – Bottom-Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top-Down Approach – Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor nano structures, growth techniques for nano structures.

UNIT IV

CHARECTERIZATION TECHNIQUES: X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezo response microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.

UNIT V

CARBON NANO TECHNOLOGY: Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalling diamond films, grapheme, and applications of carbon nano tubes.

APPLICATIONS OF NANO TECHNOLOGY: Applications in material science, surface science, energy and environment. Applications of quantum dots.

TEXT BOOKS

1. Nano science and nano technology by M.S Ramachandra Rao, Shubra Singh, Wiley publishers.

REFERENCE BOOKS

1. Introduction to Nano Technology by Charles P. Poole, Jr., Frank J.Owens, Wiley publishers.
2. Nanotechnology by Jermy J Ramsden, Elsevier publishers.
3. Nano Materials- A.K.Bandyopadhyay/ New Age Introdu.
4. Nano Essentials- T.Pradeep/TMH.
5. Nanotechnology the Science of Small by M.A Shah, K.A Shah, Wiley Publishers.
6. Principles of Nanotechnology by Phani Kumar, Scitech.

WEB REFERENCE:

1. https://nptel.ac.in/courses/113/106/113106093/
2. https://nptel.ac.in/courses/118/107/118107015/

III Year – I Semester
AUTOMATION IN MANUFACTURING

Course Category	Professional Elective	**Course Code**	19ME5T20
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Student will learn	
1.	The strategies of automation in manufacturing.
2.	The concept of automated flow lines.
3.	To classify various assembly system and line balancing and various automated material handling and storage systems.
4.	The concept of adaptive control systems.
5.	To study the various components in Automated Systems & various inspection methods.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Identify the basic fundamentals of strategies in automation, pneumatic and hydraulic components.	K2
CO2	Discuss various automated flow lines, methods of part transfer mechanism, buffer mechanism.	K2
CO3	Describe various assembly system and line balancing and various automated material handling and storage systems.	K1
CO4	Recognize the concept of adaptive control systems.	K2
CO5	Discuss about automated control systems and various inspection methods.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1	2	-	-	-	2	2	-	-	2	2
CO2	3	2	3	1	3	-	-	-	2	3	-	-	2	2
CO3	3	2	3	2	1	-	-	-	2	-	-	2	2	2
CO4	3	2	2	1	1	-	-	-	2	-	2	-	1	2
CO5	3	2	2	3	1	-	-	-	2	-	-	-	2	2

COURSE CONTENT

UNIT I:

INTRODUCTION: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, mechanical feeding and tool changing and machine tool control.

UNIT II:

AUTOMATED FLOW LINES: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT III:

ASSEMBLY SYSTEM AND LINE BALANCING: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

AUTOMATED MATERIAL HANDLING and STORAGE SYSTEMS: Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT IV:

ADAPTIVE CONTROL SYSTEMS: Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration and acoustic emission in the adaptive controls systems.

UNIT V:

AUTOMATED INSPECTION: Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision.

TEXT BOOKS

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover. PE/PHI.
2. Groover.M.P, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Publications

REFERENCE BOOKS

1. Computer Control of Manufacturing Systems by Yoram Coren.
2. CAD / CAM/ CIM by Radhakrishnan.
3. W. Buekinsham," Automation", PHI Publications, 3rd edition.

WEB RESOURCES

1. https://nptel.ac.in/courses/112/103/112103293/
2. https://nptel.ac.in/courses/112/104/112104288/
3. https://www.youtube.com/watch?v=v-3TmN4HhLc

III Year I Semester
TOTAL QUALITY MANAGEMENT

Course Category	Professional Elective	**Course Code**	19ME5T21
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2	Explain the TQM Principles for application
3	Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA
4	Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
5	Illustrate and apply QMS and EMS in any organization.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Apply TQM concepts in a selected enterprise	K2
CO2	Apply TQM principles in a selected enterprise.	K3
CO3	Understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.	K4
CO4	Understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR	K2
CO5	Apply QMS and EMS in any organization.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	2	-	-	-	-	-	-	-	1
CO3	-	-	-	-	3	-	-	-	2	-	-	-	-	-
CO4	-	2	-	-	2	2	2	1	2	-	-	-	-	-
CO5	-	-	3	-	-	2	2	1	-	-	-	-	-	-

COURSE CONTENT

UNIT I
INTRODUCTION
Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II
TQM PRINCIPLES
Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano

Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III
TQM TOOLS & TECHNIQUES I

The seven traditional tools of quality - New management tools - Six-sigma Process Capability Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV
TQM TOOLS & TECHNIQUES II

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM –Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V
QUALITY MANAGEMENT SYSTEM

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards-AS 9100, TS16949 and TL 9000-ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction-ISO 14000 Series Standards-Concepts of ISO 14001-Requirements of ISO 14001-Benefits of EMS.

TEXT BOOKS

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013..
2. L Suganthi and Anand A Samuel, Total Quality Management,PHI,,New Delhi

REFERENCE BOOKS

1. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.

WEB RESOURCES

1. https://nptel.ac.in/courses/112/104/112104115/
2. https://nptel.ac.in/courses/112/104/112104193/

III Year I Semester
MACHINE TOOLS AND THEORY OF MACHINES LABORATORY

Course Category	Professional Core	**Course Code**	19ME5L08
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Metal Cutting and Machine tools, Kinematics of Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES: The student able to	
1	Perform various machining operations using lathe machine
2	Carryout shaping drilling and tapping operations
3	Perform milling and grinding operations required for manufacturing
4	Inspect vibrational behavior of systems
5	Understand the principal of gyroscopes and governors
6	Learn static and dynamic balancing of mechanical systems

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Demonstrate the knowledge of machining on a product by using lathe machines.	K2
CO2	Develop hands on experience and learning experience in shaping drilling and tapping operations	K3
CO3	Develop skill in milling and grinding operations required for manufacturing industries.	K3
CO4	Demonstrate free and forced vibrational systems	K2
CO5	Determine the principal of gyroscopes and governors	K3
CO6	Apply the concept of static and dynamic balancing in rotating and reciprocating components.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	--	--	--	--	1	--	--	--	--	--	--	1	--
CO2	2	--	--	--	--	1	--	--	--	--	--	--	1	--
CO3	2	--	--	--	--	1	--	--	--	--	--	--	1	--
CO4	2	2	--	--	--	1	--	--	--	--	--	--	1	--
CO5	2	2	--	--	--	1	--	--	--	--	--	--	1	--
CO6	2	2	--	--	--	1	--	--	--	--	--	--	1	--

COURSE CONTENT
MACHINE TOOLS LABORATORY

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1. fundamental operations on lathe machines
   a) Plain turning and facing operations on lathe.
   b) Step turning and taper turning operation on lathe.
   c) Thread cutting and knurling operation on lathe.
   d) Drilling operation on lathe

2. Drilling and tapping.
3. Shaping and planning.

4. Slotting.
5. Milling.
6. Cylindrical surface grinding.

THEORY OF MACHINES LABORATORY

1. Study Of Four Bar Mechanism And Gears
2. To plot follower displacement Vs cam rotation for various Cam Follower systems.
3. To determine the position of sleeve against controlling force and speed of a Watt governor and to plot the characteristic curve of radius of rotation.
4. To study the static and dynamic balancing using rigid blocks.
5. To analyze the motion of a motorized gyroscope when the couple is applied along its spin axis
6. To determine the free and forced frequency of vibration of a spring mass system.
7. To determine whirling speed of shaft theoretically and experimentally.

Note: Any 10 of the above 12 experiments are to be conducted

III Year I Semester
THERMAL ENGINEERING LABORATORY

Course Category	Lab Course	**Course Code**	19ME5L09
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	IC Engines and Turbo Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	To provide hands on experience in operating various types of internal combustion engines and understand their functioning and performance

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Estimate the performance of the I.C. Engine	K4
CO2	Prepare the heat balance sheet of the I.C. Engine	K4
CO3	Estimate the performance of the reciprocating compressor	K4
CO4	Understand the sequence of operations to assemble/disassemble an IC engine & study the various processes associated with the performance of boilers.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	--	--	--	--	--	2	--	--	--	1	2
CO2	2	2	2	--	--	--	--	--	2	--	--	--	2	2
CO3	2	2	2	--	--	--	--	--	1	--	--	--	1	2
CO4	2	--	--	--	--	--	--	--	--	--	--	--	--	2

COURSE CONTENT

Note: The students have to perform minimum 10 Experiments

1. I.C. Engines valve and port timing diagrams.
2. Testing of Fuels – Viscosity, flash point/fire point, carbon residue, calorific value.
3. I.C. Engine performance test and Exhaust emission measurements (4 -stroke diesel engine)
4. I.C. Engine performance test and Exhaust emission measurements (2-stroke petrol engine)
5. Evaluation of friction power by conducting Morse test on 4-stroke multi cylinder engine.
6. Determination of Friction Power by retardation or motoring test on IC engine.
7. I.C. Engine heat balance at different loads and show the heat distribution curve.
8. Economical speed test of an IC engine.
9. Performance test on variable compression ratio engines.
10. Performance test on reciprocating air compressor unit.
11. Dis-assembly / assembly of different parts of two wheelers. 3 wheelers & 4 wheelers. Tractor & Heavy-duty engines covering 2-stroke and 4 stroke, SI and CI engines.
12. Study of boilers, mountings and accessories.
13. Performance test on Refrigeration test rig.

PREFERRED AGENCY FOR MOOCS COURSE FROM THE GIVEN LIST IN THE COURSE STRUCTURE IS **"CSWAYAM"**

III Year II Semester
INDUSTRIAL ENGINEERING AND MANAGEMENT

Course Category	Professional core	**Course Code**	19ME6T22
Course Type	Theory	**L-T-P-C**	3 -0 - 0 - 3
Prerequisites	--	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn basic principles of management and factors with respect to plant location
2	To learn the concepts of plant layouts and operation management
3	To understand the importance and techniques in quality control
4	To understand the concepts related to human resource management, industrial disputes and labour welfare
5	To apply the techniques of project management and know the importance of value analysis

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Know the importance of industrial management and plant location	K1
CO2	Design plant layouts and minimize the production time	K3
CO3	Chose proper control techniques to improve product quality	K5
CO4	Understand the methods of performance rating of human resources and human resource management	K2
CO5	Apply suitable technique for enterprise resource planning and project management	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	1	1	2	2	2	-	-	-	-	-	2	-	1	-
CO3	-	1	-	-	-	-	-	-	-	-	1	-		-
CO4	-	1	-	-	1	-	-	-	2	2	3	1	1	-
CO5	-	1	-	-	2	-	-	2	1	-	3	2	-	-

COURSE CONTENT

UNIT I

MANAGEMENT AND ORGANIZATION:

Definition – meaning and nature of management- Functions of management, Taylor's Scientific management- Fayol's Principles of management- Basic concepts related to organization- Departmentation, Delegation and Decentralization, Type of organization structures- authority, responsibility and accountability

PLANT LOCATION: Factors governing plant location, comparison of rural and urban sites

UNIT II

PLANT LAYOUT:

Types of production layouts, process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance, types of

plant layout-various data analyzing forms-travel chart.

OPERATIONS MANAGEMENT: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs

UNIT III

STATISTICAL QUALITY CONTROL: Quality control, its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R – charts X and S charts and their applications, numerical examples.

TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. Six sigma – definition, basic concepts

UNIT IV

INDUSTRIAL RELATIONS & LABOR WELFARE: Definition of Industrial dispute – causes of Industrial dispute– (Internal & External) – machinery to solve industrial disputes, grievance management, attendance and leave, labor Act-2003, Factories Act-1948, workmens Compensation Act- 1923

RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

UNIT V

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management

PROJECT MANAGEMENT: PERT, CPM – differences & applications, critical path, determination of floats, importance, project crashing, smoothing and numerical examples

TEXT BOOKS

1. Industrial Engineering and management by O.P Khanna, Khanna Publishers.
2. Industrial Engineering and Production Management, Martand Telsang, S.Chand & Company Ltd. New Delhi.

REFERENCE BOOKS

1. Industrial Engineering by Banga & Sharma.
2. Principles of Management by Koontz O‟ Donnel, McGraw Hill Publishers.
3. Statistical Quality Control by Gupta.

WEB RESOURCES

1. http://www.nptelvideos.in/2012/12/industrial-engineering.html
2. https://www.managementstudyguide.com/value-analysis.htm
3. https://managementhelp.org/projectmanagement/

III Year II Semester

INSTRUMENTATION AND CONTROL SYSTEMS

Course Category	Professional Core	**Course Code**	19ME6T23
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To impart the knowledge of basic principles of measurement and Understanding the concept of Measurement of displacement.
2	To impart the knowledge of basic principles of measurement of Temperature, Pressure.
3	To enable student, Measure Level, Flow, speed with the help of suitable instruments.
4	To enable student, Measure Humidity level, Force, Torque and Power and impart the knowledge to measurement Acceleration and Vibration, Stress & Strain.
5	To enable the student to be able to learn about control system and their purpose.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze the performance characteristics of the instrument and will choose the suitable instrument to measure displacement.	K4
CO2	Select the suitable instruments to measure temperature and pressure in industrial applications.	K3
CO3	Select the suitable instruments to measure level, flow, and speed in industrial applications.	K3
CO4	Identify suitable instruments to measure humidity level, force, torque, power, stress, strain, acceleration and vibration.	K3
CO5	Classify and usage of control systems in various industrial applications.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	-	3	-	-	-	-	-	-	-	2	-	1
CO2	3	1	-	2	2	2	-	-	-	-	-	2	1	1
CO3	3	1	1	2	2	-	-	-	-	-	-	2	1	1
CO4	3	1	1	2	2	2	-	-	-	-	-	2	1	1
CO5	3	1	-	1	-	-	-	-	-	-	-	2	1	1

COURSE CONTENT

UNIT I

Definition – Basic principles of measurement – measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Definitions and basic concepts of accuracy,

precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity. Dynamic performance characteristics – sources of error, classification and elimination of error.
Measurement of Displacement: Theory and construction of various transducers to measure displacement – piezo-electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

UNIT II
Measurement of Temperature: Classification – ranges –various principles of measurement – expansion, electrical resistance – thermistor – thermocouple – pyrometers – temperature indicators.
Measurement of Pressure: Units – classification – different principles used. manometers, piston, bourdon pressure gauges, bellows – diaphragm gauges. low pressure measurement – thermal conductivity gauges– ionization pressure gauges, McLeod pressure gauge. Knudsen gauge.

UNIT III
Measurement of Level: Direct method – indirect methods –capacitative, ultrasonic, magnetic, cryogenic fuel level indicators – bubbler level indicators
Flow Measurement: Rotameter, magnetic, ultrasonic, turbine flow meter, hot – wire anemometer, laser Doppler anemometer (LDA).
Measurement of Speed : Mechanical tachometers – electrical tachometers – stroboscope, noncontact type of tachometer

UNIT IV
Measurement of Acceleration and Vibration: Different simple instruments– principles of seismic instruments – vibrometer and accelerometer using this principle.
Measurement of Humidity – Moisture content of gases, sling psychrometer, absorption psychrometer, dew point meter.
Measurement of Force, Torque and Power, - Elastic force meters, load cells, torsion meters, dynamometers, **Stress-Strain Measurement** – Various types of stress-strain measurements, Electrical strain gauge – Gauge factor – Method of resistance strain gauge for bending compressive and tensile strains

UNIT V
ELEMENTS OF CONTROL SYSTEMS: Introduction, importance –classification – open and closed loop systems, servomechanisms–examples with block diagrams–temperature, speed & position control systems.

TEXT BOOKS
1. Measurement Systems: Applications & design by D.S Kumar, PHI
2. Mechanical Measurements / BeckWith, Marangoni,Linehard, PHI / PE.

REFERENCE BOOKS

1. Measurement systems: Application and design, Doeblin Earnest. O. Adaptation by Manik and Dhanesh/ TMH.
2. Experimental Methods for Engineers / Holman.
3. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
4. Instrumentation, measurement & analysis by B.C.Nakra & K.K.Choudhary, TMH.
5. Mechanical Measurements by R.S. Sirohi and Radha Krishnan, Jain Publications, 2009.

WEB RESOURCES
1. http://www.nptelvideos.in/2012/11/process-control-and-instrumentation.html

III Year II Semester
METROLOGY

Course Category	Professional Core	**Course Code**	19ME6T24
Course Type	Theory	**L-T-P-C**	3 -0-0-3
Prerequisites	Nil	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To Learn about the factors affecting measurements and various tolerances used manufacturing and assembly process.
2	To Known the working principle and applications of various linear and angular measuring instruments.
3	Impact Knowledge on basic concepts of measurement of assembly and transmission elements.
4	To Learn the principles and methods of form and surface metrology.
5	To Learn the advance in measurements for quality control in manufacturing Industries.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the factors affecting measurements and various tolerances used in manufacturing and assembly process.	K2
CO2	Apply the working principles of linear and angular measurements.	K3
CO3	Apply basic concepts of measurement in assembly and transmission elements.	K3
CO4	Apply the principles and methods of form and surface metrology.	K3
CO5	Apply the advance in measurements for quality control in manufacturing Industries	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	--	--	--	1	--	1	1	--	--	--	--	--
CO2	1	--	2	--	--	2	--	--	1	1	--	--	1	--
CO3	1	1	1	--	--	1	--	--	--	--	--	--	1	--
CO4	--	2	--	--	--	--	--	--	--	--	--	--	1	--
CO5	--	--	--	--	--	--	--	--	--	--	--	1	1	--

COURSE CONTENT

UNIT I

BASICS OF METROLOGY: Measurement – Need, Process, Role in quality control; Factors affecting measurement, Errors in Measurements – Types – Control – Measurement uncertainty, ISO standards.

TOLERANCE ANALYSIS: Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

UNIT-II

Linear Measuring Instruments: Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and

advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope.

UNIT-III

Measurement of Screw threads: Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

UNIT IV

METROLOGY OF SURFACES

Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations, etc. Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.

UNIT V

ADVANCES IN METROLOGY

Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners

TEXT BOOKS

1. Engineering Metrology by R.K.Jain / Khanna Publishers
2. Engineering Metrology by I.C.Gupta / Dhanpat Rai Publishers
3. Fundamentals of Dimensional Metrology by Dotson Connie, Cengage Learning, First edition, 2012.

REFERENCE BOOKS

1. Dimensional Metrology, Connie Dotson, Cengage Learning.
2. Engineering Metrology by Mahajan / Dhanpat Rai Publishers
3. Engineering Metrology by KL Narayana, Scitech publishers.
4. A Text Book of Production Engineering, P.C. Sharma, S. Chand Pub.
5. Engineering Metrology and Measurements by NV Raghavendra, L Krishna murthy, Oxford publishers.

WEB RESOURCES

1. http://nptel.ac.in/courses/112106179/10
2. http://nptel.ac.in/courses/112106179/17
3. http://nptel.ac.in/courses/112106179/23
4. http://nptel.ac.in/courses/112106179/31
5. http://nptel.ac.in/courses/112106179/32
6. http://nptel.ac.in/courses/112106179/35
7. http://nptel.ac.in/courses/112106179/37

III Year II Semester
HEAT TRANSFER

Course Category	Professional Core	**Course Code**	19ME6T25
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	IC Engines and Turbo Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES **Student will learn about**	
1	The basic differential equations of heat transfer in various modes.
2	The knowledge of heat transfer and temperature distribution of various fins.
3	Empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient.
4	About boiling, condensation and the concepts of LMTD, NTU for heat exchangers
5	About the concepts of radiation heat transfer.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze the basic Heat transfer concepts and their physical relevance in planes, cylinders and spherical components.	K4
CO2	Analyze the system with heat generation, variable thermal conductivity, fins and 1D transient conduction heat transfer problems.	K4
CO3	Apply fundamental concepts and principles in Convective Heat transfer and formulate the relationship among the parameters in flow of fluids using Buckingham Pi Theorem.	K4
CO4	Analyze the performance of heat exchanger using LMTD and NTU method	K4
CO5	Analyze heat transfer system involving phase change and radiation.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	--	--	--	--	--	--	--	--	--	--	2	--
CO2	1	3	1	--	--	--	--	--	--	--	--	--	1	--
CO3	2	3	3	2	--	--	--	--	--	--	--	--	2	--
CO4	2	2	1	1	--	--	--	--	--	--	--	--	2	--
CO5	1	2	1	--	--	--	--	--	--	--	--	--	1	--

COURSE CONTENT

UNIT I

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT II

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body

UNIT III

Dimensional analysis: Dimensional analysis as a tool for experimental investigation Buckingham Π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

UNIT IV

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT V

Heat Transfer with Phase Change:

Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS

1. Heat Transfer by HOLMAN, Tata Mcgraw Hill
2. Fundamentals of Engineering Heat and Mass Transfer — R.C. Sachdeva - New Age Intl. Publishers 2ndEdition, 2005
3. Heat and Mass Transfer- P.K.Nag-TMH 2nd Edition, 2007
4. Heat and Mass Transfer by R.K.Rajput, S.Chand Publications 3rd Edition.

REFERENCE BOOKS

1. Heat transfer - . J.P.Holman, Tata McGraw-Hill, 9th Edition, 2010.
2. Heat & Mass Transfer-A Practical Approach – Yunus. A. Cengel, Tata McGraw Hill, 4th Edition, 2012.
3. Heat Transfer - P.S.Ghoshdastidar- Oxford Higher Education 6th Edition 2011.

DATA HAND BOOK

1. Heat and Mass Transfer Data Book, C.P. Kothandaraman and Subramanian New Age International Publications, 7th Edition, Reprint 2012.

WEB RESOURCES

1. https://nptel.ac.in/courses/112/105/112105271/
2. https://nptel.ac.in/courses/112/108/112108246/

III Year II Semester
POWER PLANT ENGINEERING

Course Category	Professional Elective	**Course Code**	19ME6T26
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	IC Engines and Turbo Machinery, Fluid Mechanics and Hydraulic Machines	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Student can learn about power generation through prime movers by using steam.
2	Student can learn about power generation through prime movers by using Diesel and Gas energy
3	Student can learn about power generation through prime movers by using hydro power and non-conventional energy such as solar, wind and tidal.
4	Student can able to understand the power generation through Nuclear Reactors.
5	Student can able to understood the importance of economic and environmental considerations of power plants

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the functions of the different components of steam power plant.	K2
CO2	Illustrate the working of Diesel and Gas power plant.	K2
CO3	Demonstrate the working of hydal power plant and non conventional energy generation	K2
CO4	Classify different reactors for power generation and Explain the working of nuclear plants	K2
CO5	Estimate various costs related to the economics of power plants.	K5

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	1	-	-	-	-	-	2	-
CO4	3	2	1	-	-	2	2	3	-	-	-	2	2	-
CO5	2	2	-	3	3	2	3	3	3	-	2	3	2	3

COURSE CONTENT

UNIT I: Steam Power Plant

Introduction to the Sources of Energy – Resources and Development of Power in India. Steam Power Plant: Plant Layout, Working of different Circuits, Fuel and handling equipment's, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems.

COMBUSTION PROCESS: Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.

UNIT II: INTERNAL COMBUSTION ENGINE PLANT

DIESEL POWER PLANT: Introduction – IC Engines, types, construction– Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging.

GAS TURBINE PLANT: Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.

UNIT III: HYDRO ELECTRIC POWER PLANT

Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.

HYDRO PROJECTS AND PLANT: Classification – Typical layouts – plant auxiliaries – plant operation pumped storage plants.

POWER FROM NON-CONVENTIONAL SOURCES: Utilization of Solar energy, Fuel cells, Thermo electric and Thermo ionic, MHD generation- Collectors Principle of Working, Wind Energy – types – HAWT, VAWT -Tidal Energy.

UNIT IV: NUCLEAR POWER STATION

Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation.

TYPES OF REACTORS: Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal.

UNIT V: POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS

Power Plant Economics and Environmental Considerations: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor– related exercises. Effluents from power plants and Impact on environment – pollutants and pollution standards – Methods of Pollution control.

TEXT BOOKS

1. Power Plant Engineering – P.C.Sharma / S.K.Kataria Pub
2. A Course in Power Plant Engineering: / Arora and S. Domkundwar.

REFERENCE BOOKS

1. A Text Book of Power Plant Engineering / Rajput / Laxmi Publications
2. Power plant Engineering/ Ramalingam/ Scietech Publishers
3. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
4. An Introduction to Power Plant Technology / G.D. Rai.
5. Power plant Engg - Elanchezhian- I.K. International Publications.

WEB RESOURCES

1. http://nptel.ac.in/courses/112106133/1
2. http://nptel.ac.in/courses/112106133/2
3. http://nptel.ac.in/courses/112106133/3
4. http://nptel.ac.in/courses/112106133/4

III Year II Semester
MECHATRONICS

Course Category	Professional Elective	**Course Code**	19ME6T27
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To impart knowledge about mechatronic systems and their response.
2	To acquire knowledge about solid-state electronic devices and various actuating systems.
3	To learn mathematical modelling of physical systems.
4	To familiarize closed loop controllers and their modes.
5	To impart knowledge on programming of microprocessors and learn practical applications of mechatronic systems.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain various components and sensors related to mechatronics systems.	K2
CO2	Apply signal conditioning and identify the required actuating system.	K3
CO3	Develop basic mathematical models in mechatronic systems.	K3
CO4	Develop appropriate controller using different modes for a given mechatronic system.	K3
CO5	Make use of microprocessors and PLCs in the areas of Robotics, Automobiles etc.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	3	-	-	-	-	2	-	-	-	3	-
CO2	3	3	2	-	-	-	-	-	2	-	-	-	3	-
CO3	3	3	3	3	-	-	-	-	3	-	-	-	3	-
CO4	3	-	2	2	-	-	-	-	2	-	-	-	3	-
CO5	3	3	3	2	-	-	-	-	3	-	-	-	3	-

COURSE CONTENT

UNIT I

Introduction to Mechatronics systems**.**

Sensors and transducers: Introduction, performance terminology - Classification: displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors - Selection of sensors.

UNIT II

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs.

Signal Conditioning: Introduction - Operational amplifiers: Inverting amplifier, summing amplifier, integrating amplifier, difference amplifier - Filtering process.

Hydraulic and pneumatic actuating systems - Hydraulic systems, and pneumatic systems, components, control valves. Mechanical and electrical actuating systems.

UNIT III

Basic system models: Mathematical models - mechanical, electrical and fluid system building blocks - Mechanical translational systems, Mechanical rotational systems, Electromechanical systems.

UNIT IV

Closed loop controllers: Continuous and discrete process - Control modes: Two step mode, Proportional mode, derivative control, integral control – PID Controllers, Digital Controllers – Velocity control, adaptive control.

UNIT V

Microprocessors: Microprocessor systems, micro controllers, applications

PLC: Introduction, basic structure - Input/output processing - Ladder programming - timers, internal relays and counters, selection of PLC.

Case studies of Mechatronic Systems: Pick and place robot, Digital camera, Automotive control.

TEXT BOOKS

1. Mechatronics- Electronic control systems in Mechanical and Electrical Engineering by W. Bolton, Pearson Education, 4th Edition.
2. Mechatronics- Integrated Mechanical Electronics Systems by K P Ramachandran, G K Vijaya Raghavan & M S Balasundaram, WILEY India Edition.

REFERENCE BOOKS

1. Introduction to Mechatronics by David and Alcaitore Michael B. Histand TMH, 4th Edition, 2006.
2. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai, 1st edition, 2003.
3. Mechatronics by N. Shanmugam, Anuradha Agencies Publishers.
4. Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics by Lawrence J. Kamm, IEEE Press, 2nd Edition, 2000.

WEB RESOURCES

1. http://www.engr.sjsu.edu/sjlee/vendors.htm
2. www.cambridgemechatronics.com/contact/terms
3. www.pdf-free-download.com/mechatronics-labs.pdf
4. www.mechatronics.me.wisc.edu
5. https://www.electronicshub.org/different-types-sensors/
6. www.engr.colostate.edu/~dga/mechatronics/resources.html
7. www.NI.com
8. https://en.wikipedia.org/wiki/Solid-state_electronics
9. http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulicand-electrical-actuators/
10. https://www.worldscientific.com/worldscibooks/10.1142/10193

III Year II Semester
INDUSTRIAL ROBOTICS

Course Category	Professional Elective	**Course Code**	19ME6T28
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	NIL	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To impart knowledge about industrial robots and their configurations.
2	To acquire knowledge about components of industrial robots.
3	To learn sensing and machine vision.
4	To familiarize robot programming.
5	To impart knowledge industrial applications.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain various robots and their configuration related to industries.	K2
CO2	Demonstrate working of various components of industrial robots.	K2
CO3	Illustrate robot sensing and machine vision.	K2
CO4	Make use of robot programming and artificial intelligence.	K3
CO5	Develop industrial applications in various conditions.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	2	-	-	-	-	2	-	-	-	3	-
CO2	3	3	2	2	-	-	-	-	2	-	-	-	3	-
CO3	3	3	2	2	-	-	-	-	2	-	-	-	3	-
CO4	3	3	2	2	-	-	-	-	2	-	-	-	3	-
CO5	3	3	2	2	-	-	-	-	2	-	-	-	3	-

COURSE CONTENT

UNIT I
Introduction:
Definition of a robot – Basic concepts, types of industrial robots – Robot configurations – Types of robot drives – Basic robot motions – point to point control, continuous path control. Programming of Robots and Vision System-Lead through programming methods- Teach pendent overview
Of various textual programming languages like VAL etc.

UNIT II
Components of the Industrial Robotics: Function line diagram representation of robot arms, common types of arms. Manipulators - Types of Robot end effectors - Grippers - Tools as end effectors - Robot/End - effort interface.
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors.
Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.

UNIT III

Sensing:

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing.

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H Transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for Industrial robots. Differential Kinematics for planar serial robots

UNIT IV

Trajectory planning: Joint space scheme- Cubic polynomial fit-Obstacle avoidance in operation space-cubic polynomial fit with via point, bleding scheme. Introduction Cartesian space scheme. Control-Interaction control, Rigid Body mechanics, Control architecture- position, path velocity, and force control systems, computed torque control, adaptive control, and Servo system for robot control.

UNIT V

Industrial Applications:

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

TEXT BOOKS

1. Industrial Robotics by Mikell P Groover, Pearson Education.
2. Robotics and Control by Mittal R K & Nagrath I J, TMH Publications.

REFERENCE BOOKS

1. Robotic Engineering – An integrated Approach by Richard D Klafter, Thomas Achmielewski and Mickael Negin, Prentice Hall India, New Delhi, 2001.
2. Automation, Production Systems, and Computer-Integrated Manufacturing by Mikell P Groover, Pearson Education, 2015.
3. Robotics Control sensing, Vision and Intelligence by K.S. Fu., R.C. Gonalez, C.S.G. Lee, McGraw Hill International Edition, 1987.

WEB RESOURCES

1. http://www.nptel.ac.in/courses/112101099/1#
2. https://www.toptal.com/robotics/programming-a-robot-an-introductory-tutorial#:~:text=Two%20main%20programming%20languages%20are,tests%20or%20proof%20of%20concepts.
3. https://www.plantautomation-technology.com/articles/different-types-of-robot-programming-languages

III Year II Semester
SUPPLY CHAIN MANAGEMENT

Course Category	Professional Elective	**Course Code**	19ME6T29
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Nil	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand importance of Supply chain management frame work in business management
2	To learn Supply Chain Drivers and Metrics
3	To impart knowledge on Designing Supply Chain Network
4	To understand forecasting and risk management
5	To understand aggregate planning and inventory

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the importance of Supply chain management frame work in business management	K2
CO2	Illustrate Supply Chain Drivers and Metrics to determine the supply chain's performance in terms of responsiveness and efficiency	K2
CO3	Apply supply chain network aspects for various manufacturing sectors	K3
CO4	Explain the role of forecasting in supply chain management	K2
CO5	Apply the concept of aggregate planning and inventory decisions in supply chain	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	--	--	--	--	--	1	--	--	1	--	--	--	--	--
CO2	--	--	--	--	--	2	--	--	2	--	1	--	1	--
CO3	--	1	--	--	--	1	--	--	2	--	1	2	1	--
CO4	--	--	--	--	--	2	--	--	1	--	2	2	2	--
CO5	--	1	2	--		2	--	--	1	--	2	2	2	--

COURSE CONTENT

UNIT I
Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope.

UNIT II
Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit.

UNIT III
Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions,

Models for Facility Location and Capacity Allocation.

UNIT IV

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting.

UNIT V

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect.

TEXT BOOKS

1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation,4th Edition, Pearson Education Asia, 2010.
2. David Simchi-Levi, PhilpKamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

REFERENCE BOOKS

1. Supply Chain Management: A Logistics Perspective, Hardcover Book, Coyle, John J. (Author),
2. Strategic Supply Chain Management: The Five Core Disciplines for Top Performance, Second Edition, McGraw-Hill, Cohen, Shoshanah (Author)

WEB RESOURCES

1. https://www.youtube.com/watch?v=raqi4gjMLm8
2. https://www.youtube.com/watch?v=Nrl0CtS1m8Y

III Year II Semester
HEAT TRANSFER LABORATORY

Course Category	Lab course	**Course Code**	19ME6L10
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Heat Transfer	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES
Student will get

The practical exposure with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling for several geometries.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Perform steady state conduction experiments to estimate thermal conductivity &Overall heat transfer coefficient of different materials.	K2
CO2	Estimate Heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values	K2
CO3	Perform Radiation experiments: Determine Surface emissivity of a test plate and Stefan-Boltzman constant and Determine thermal properties and performance of Heat exchanger.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	2	--	--	--	--	--	--	--	--	2	1
CO2	2	1	2	2	--	--	--	--	--	--	--	--	2	1
CO3	2	1	2	2	--	--	--	--	--	--	--	--	2	1

LIST OF EXPERIMENTS

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe
3. Determination of heat transfer rate through a concentric sphere
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin
6. Determination of heat transfer coefficient in natural and forced convection
7. Determination of effectiveness of parallel and counter flow heat exchangers.
8. Determination of emissivity of a given surface.
9. Determination of Stefan Boltzman constant.
10. Determination of heat transfer rate in drop and film wise condensation.
11. Determination of critical heat flux.
12. Determination of Thermal conductivity of liquids and gases.
13. Investigation of Lambert's cosine law.
14. COP of VCR System with Capillary and thermal expansion valve.

Note: Any 12 of the above experiments are to be conducted

III Year II Semester
METROLOGY AND INSTRUMENTATION LABOROTARY

Course Category	Lab course	**Course Code**	16ME6L11
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	Metrology and Instrumentation & Control Systems	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
1	The Metrology and instrumentation Laboratory course is designed for measuring and gauging instruments for inspection of precision linear, geometric forms, angular and surface finish measurements. The student can learn the measurements with and calibration of instruments. They also understand the machine tool alignment test.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Demonstrate the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness	K3
CO2	Demonstrate the measure of angle by sine bar and universal bevel protractor	K3
CO3	Demonstrate the use of instruments of measuring pressure, flow, speed, displacement, temperature.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	3	--	--	2	--	--	--	3	--	2	3	3
CO2	2	3	3	--	--	2	--	--	--	3	--	2	3	3
CO3	3	3	3	--	--	2	--	--	--	3	--	2	3	3

COURSE CONTENT

1. Measurements of lengths, heights, diameters by Vernier calipers.
2. Measurement of bores by dial bore indicators.
3. Use of gear tooth calipers for tooth thickness inspection and flange Micrometer for checking the chordal thickness of spur gear.
4. Angle measurements and tape measurements with bevel protractor.
5. Angle measurements and tape measurements with sine bars.
6. Measurement of the specimen by Screw gauge.
7. Study and calibration of LVDT transducer for displacement measurement.
8. Study and calibration of Rotameter.
9. Study and calibration of speed measurement.
10. Study and calibration of capacitive transducer.
11. Study and calibration of RTD
12. Study and calibration of MCLEOD GAUGE.
13. Study and calibration of Dead weight pressure gauge

Note: Any 10 of the above 13 experiments are to be conducted.

IV Year I Semester
CAD/CAM

Course Category	Professional Core	**Course Code**	19ME7T30
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Production Technology, Metal cutting and Machine tools	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Understand various modules of CAD & CAM and apply the concepts for Geometry Transformation techniques Digitally.
2	Create and Manipulate the different geometric modelling techniques.
3	Understand various concepts of Part Programming for NC and CNC Elements
4	Demonstrate the concepts of GT, CAPP and FMS
5	Able to Understand various Quality Control and Testing Techniques using Computers, and their Integration to Manufacturing.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level (Highest)**
CO1	Demonstrate various Geometrical transformation techniques and Understand the working of various CAD and CAM Elements.	K2
CO2	Demonstrate the different representations in the geometric modules.	K2
CO3	Apply the concepts of NC and CNC Programming and write program for NC/CNC Turning and Machining Centers.	K3
CO4	Distinguish various Grouping Concepts and Summarize the use of computers in manufacturing and the manufacturing process planning.	K2
CO5	Identify the advantages and disadvantages in integrating computers in Quality Control, Testing and Manufacturing.	K1

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	--	3	--	2	--	--	--	--	2	--	--	2	--
CO2	1	1	3	--	3	1	--	--	--	3	1	--	2	--
CO3	2	3	3	2	2	2	--	--	--	--	2	1	1	--
CO4	--	3	2	--	2	1	--	--	--	--	2	1	1	--
CO5	3	3	2	3	1	-	--	--	--	2	--	1	2	--

COURSE CONTENT

UNIT I:

Fundamentals of CAD: Computers In Industrial Manufacturing, Product Cycle, CAD / CAM Hardware, Basic Structure of CAD/CAM Systems-Input Devices, CPU and Output Devices.

Computer Graphics: Working of a CRT Display device-Random Scan and Raster Scan Graphics Coordinate System, Database Structure For Graphics Modeling, Transformation Of Geometry, 3D Transformations, Mathematics Of Projections, Clipping-Cohen Sutherland Clipping Algorithm, Hidden Surface Removal.

UNIT II:

Geometric Modeling: Requirements, geometric models, geometric construction models, Curve representation methods, surface representation methods, modeling facilities desired. Solid modeling - solid representation, boundary representation and constructive solid geometry.

UNIT III:

Part Programming for NC Machines: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, Turning center,

Part Programming for CNC Machines: Fundamentals, Manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.

UNIT IV:

Group Technology (GT): Part family, coding and classification, production flow analysis, types and advantages.

Computer aided processes planning (CAPP): Importance, types-Retrieval type CAPP system, Generative type CAPP system and Hybrid CAPP System, benefits of CAPP.

Flexible Manufacturing Systems (FMS): Introduction, Equipment, Tool Management Systems, Layouts, FMS control.

UNIT V:

Computer Aided Quality Control: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, Computer Aided Testing (CAT), integration of CAQC with CAD/CAM.

Computer Integrated Manufacturing Systems: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.

TEXT BOOKS

1. CAD / CAM / CAE E Zimmers & M.Groover/Pearson Education
2. Automation, Production systems & Computer integrated Manufacturing/ Groover/P.E
3. Principles and applications of CAD/CAM by J.Srinivas, Oxford University Press, N.D, 2017

REFERENCE BOOKS

1. CAD / CAM Theory and Practice / Ibrahim Zeid / TMH.
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson.
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson.
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang, Elsevier Publishers.
5. CAD/CAM/CIM by P. Radhakrishnan, S.Subramanyan, V.Raju, New age Publications.

WEB RESOURCES

1. http://nptel.ac.in/courses/112102101/

IV Year I Semester
FINITE ELEMENT METHODS

Course Category	Professional Core	**Course Code**	19ME7T31
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Mechanics of Solids	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn basic principles of finite element analysis procedure, Concept of discretization and characteristics of finite elements that represent engineering structures.
2	To learn the theory and characteristics of finite elements that represent engineering structures-Trusses and Beams
3	To learn and apply finite element solutions to structural, thermal and dynamic problems.
4	Learn to model complex geometry problems and solution techniques.
5	To solve heat transfer and other field problems using FEM and FE procedure for dynamic analysis of structures.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Understand the concepts behind variational methods and weighted residual methods in FEM	K2
CO2	Identify the application and characteristics of FEA elements such as Trusses, beams.	K3
CO3	Identify the application and characteristics of FEA elements such as constant strain triangles and isoparametric elements, and axisymmetric problems.	K4
CO4	Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.	K5
CO5	Able to apply the FE procedure to field problems like heat transfer.	K6

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1	2	-	-	-	2	2	-	-	2	2
CO2	3	2	3	1	3	-	-	-	2	3	-	-	2	2
CO3	3	2	3	2	1	-	-	-	2	-	-	2	2	2
CO4	3	2	2	1	1	-	-	-	2	-	2	-	1	2
CO5	3	2	2	3	1	-	-	-	2	-	-	-	2	2

COURSE CONTENT

UNIT I

Introduction: basic concepts, historical back ground, applications of FEM, general description, Comparison of FEM with other methods**,** stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, and one dimensional problems.

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, and mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT II

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT V

Steady state heat transfer analysis: one dimensional analysis of a fin and two dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of Eigen values and Eigen vectors, free vibration analysis.

TEXT BOOKS

1. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D. Belegundu, Pearson Publishers.
2. The Finite Element Methods in Engineering / SS Rao / Pergamon

REFERENCE BOOKS

1. Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method / JN Reddy / McGraw Hill.
3. Finite Element Methods Basic Concepts and Applications/ Chennakesava R.Alavala PHI Learning Private Limited
4. Fundamentals of Finite Element Analysis/ David V.Hutton/ Mc Graw Hill Education
5. A first Course in the Finite Element Method/Daryl L. Logan/ Cengace Learning
6. Finite Element Analysis Theory and Application with ANSYS/Saeed Moaveni/Pearson

WEB RESOURCES

1. https://nptel.ac.in/courses/112/104/112104115/
2. https://nptel.ac.in/courses/112/104/112104193/
3. https://nptel.ac.in/courses/112/104/112104205/
4. https://nptel.ac.in/courses/105/106/105106051/
5. https://nptel.ac.in/courses/105/105/105105041/

IV Year I Semester

REFRIGERATION & AIR CONDITIONING

(Refrigeration and Psychrometric tables and charts allowed)

Course Category	Program Elective	**Course Code**	19ME7T32
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	IC Engines and Turbo Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To impart basic knowledge of refrigeration, study air refrigeration cycles and aircraft refrigeration.
2	To make students aware of vapour compression systems and usage of p-h charts.
3	To study various components used in VCR systems and types of refrigerants.
4	To make students aware of vapour absorption system and Steam jet refrigeration system.
5	To impart knowledge of psychrometric properties, processes used in air-conditioning.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Demonstrate the importance of different refrigeration systems and air refrigeration systems in aircrafts.	K2
CO2	Analyze vapour compression refrigeration cycle and identify influence of various parameters on system performance	K4
CO3	Explain about different components and refrigerants used in vapour compression refrigeration system.	K2
CO4	Explain about vapour absorption system and steam jet refrigeration systems.	K2
CO5	Perform cooling load calculations and select the appropriate process equipment for air-conditioning.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	--	--	2	--	--	--	--	--	--	--	1	1
CO2	2	--	1	2	1	--	--	--	--	--	--	--	2	--
CO3	3	1	--	--	1	--	--	--	--	--	--	--	1	--
CO4	3	2	--	--	1	--	--	--	--	--	--	--	2	--
CO5	2	1	1	2	3	--	--	--	--	--	--	--	1	2

COURSE CONTENT

UNIT I

INTRODUCTION TO REFRIGERATION: Necessity and applications –unit of refrigeration and COP.
REFRIGERATION: Mechanical refrigeration -types of ideal cycles of refrigeration air refrigeration: bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

UNIT II

VAPOUR COMPRESSION REFRIGERATION SYSTEM:
Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle

analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

UNIT III

REFRIGERANTS – Desirable properties – classification - refrigerants used - nomenclature – ozone depletion – global warming.

VCR SYSTEM COMPONENTS: Compressors – general classification –comparison – advantages and disadvantages. condensers – classification – working principles evaporators – classification – working principles, expansion devices – types – working principles.

UNIT IV

VAPOUR ABSORPTION SYSTEM:

Calculation of maximum COP–description and working of NH3 – water system and Li Br –water (Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.

STEAM JET REFRIGERATION SYSTEM: Working Principle and Basic Components.

NONCONVENTIONAL REFRIGERATION METHODS: Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube

UNIT V

INTRODUCTION TO AIR CONDITIONING: Psychometric properties &processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF-problems, concept of ESHF and ADP temperature, air conditioning load calculations.

TEXT BOOKS

1. Refrigeration and air conditioning, C.P. Arora., Tata McGraw-Hill Education.
2. A Course in Refrigeration and Air conditioning, Domkundwar, S.C. Arora, Dhanpatrai Publications, New Delhi, India.

DATA BOOKS

1. Refrigeration and Air Conditioning Data book, S. Domakundwar, Dhanpathi rai & CO.
2. Refrigeration and Air Conditioning Data book, CP Kothandaraman, New age publishers.

REFERENCE BOOKS

1. Refrigeration and Air conditioning, Manohar Prasad, New Age international.
2. Refrigeration and Air Conditioning, R K Rajput, S K kataria & sons.
3. Principles of Refrigeration, Roy J. Dossat · Thomas J. Horan, Pearson Education India.
4. Refrigeration and Air conditioning, R. S. Khurmi, J. K. Gupta, S. Chand.

WEB RESOURCES

1. http://nptel.ac.in/courses/112106133/23
2. http://nptel.ac.in/courses/112106133/28
3. http://nptel.ac.in/courses/112106133/30
4. http://nptel.ac.in/courses/112106133/31
5. http://nptel.ac.in/courses/112106133/32

IV Year I Semester
MEMS - MICRO ELECTRO MECHANICAL SYSTEMS

Course Category	Professional Elective	**Course Code**	19ME7T33
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Nil	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The students able to understand the working of mechanical sensors and actuators
2	The students able to understand the working of thermal & magnetic sensors and actuators
3	The students able to understand the working of micro-opto-electro mechanical systems
4	The students able to understand the working of radio frequency (RF) mems micro fluidic systems
5	The students able to understand the working of chemical and bio medical micro systems

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	understand the working of mechanical sensors and actuators	K2
CO2	understand the working of thermal & magnetic sensors and actuators	K2
CO3	understand the working of micro-opto-electro mechanical systems	K2
CO4	understand the working of radio frequency (RF) mems and micro fluidic systems	K2
CO5	understand the working of chemical and bio medical micro systems	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	--	1	--	--	--	--	--	--	--	--	1	1	--
CO2	2	--	1	--	--	--	2	--	--	--	--	1	1	--
CO3	2	--	1	--	--	--	--	--	--	--	--	1	3	--
CO4	2	--	--	--	--	--	--	--	--	--	--	1	3	--
CO5	2	--	--	--	--	--	2	--	--	--	--	1	2	--

COURSE CONTENT

UNIT I

INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT II

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT III

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

UNIT IV

RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps.

UNIT V

CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane transducer materials, chem.-lab-on-a-chip (CLOC) chemoresistors, chemocapacitors, chemotransistors, electronic nose (Enose), mass sensitive chemosensors, fluroscence detection, calorimetric spectroscopy.

TEXT BOOKS

1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.
2. Foundation of MEMS, Chang Liu, Prentice Hall Ltd

REFERENCE BOOKS

1. Bio-MEMS (Micro systems), Gerald Urban, Springer.
2. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers

WEB RESOURCES

1. https://www.youtube.com/watch?v=hv-aBonZMRQ
2. https://www.youtube.com/watch?v=j9y0gfN9WMg

IV Year I Semester
ADDITIVE MANUFACTURING

Course Category	Professional Elective	**Course Code**	19ME7T34
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Production Technology	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Students will learn	
1	Fundamentals of rapid prototyping and concepts of liquid-based rapid prototyping systems.
2	Concepts of solid-based rapid prototyping systems.
3	Concepts of powder-based rapid prototyping systems.
4	Different rapid tooling processes.
5	Rapid prototyping data formats and applications of additive manufacturing in various industries.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the rapid prototyping fundamentals & select different liquid based rapid prototyping processes for manufacturing	K2
CO2	Recognize different solid based rapid prototyping processes for manufacturing	K2
CO3	Identify different powder based rapid prototyping processes for manufacturing	K2
CO4	Describe different rapid tooling processes for prototyping manufacturing	K1
CO5	Express the uses of additive manufacturing processes in various industries.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	2	1	-	-	-	-	-	-	-	1	2	-
CO2	1	2	2	1	-	-	-	-	-	-	-	1	2	-
CO3	1	2	2	1	-	-	-	-	-	-	-	1	2	-
CO4	1	2	2	1	-	-	-	-	-	-	-	-	1	-
CO5	1	-	-	-	1	-	-	-	-	-	-	-	-	-

COURSE CONTENT

UNIT I

INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.

LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Photopolymers, photo polymerization, layering technology, laser and laser scanning.

Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT II

SOLID-BASED RAPID PROTOTYPING SYSTEMS:

Laminated object manufacturing (LOM) - models and specifications, process, working principle,

applications, advantages and disadvantages, case studies.
Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT III
POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.
Three-dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies

UNIT IV
RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting, 3D Keltool process. Direct rapid tooling: direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT V
RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translator and Newly Proposed Formats.
RP APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewellery industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of bimolecular.

TEXT BOOKS
1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2-1-.
2. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2--3

REFERENCE BOOKS
1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2--7.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2--6.
3. Hilton P.D. and Jacobs P.F., “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2.

WEB RESOURCES
1. nptel.ac.in/courses/1121-42-4/47
2. nptel.ac.in/courses/1121-7-78/37
3. https://www.youtube.com/watch?v=kNz-TM4zPkE&list=PLbTLRuAivTCR-YVCNxSTPI9lgccanmZLG&index=1
4. https://www.youtube.com/watch?v=vbsktmRv9o4&list=PLbTLRuAivTCR-YVCNxSTPI9lgccanmZLG&index=2
5. https://lecturenotes.in/m/46-59-note-of-additive-manufacturing-by-madhura-diwakar?reading=true
6. https://www.slideshare.net/badebhau/additive-manufacturing-processes-pdf-by-badebhau4gmailcom.

IV Year I Semester
OPTIMIZATION TECHNIQUES

Course Category	Professional Elective	**Course Code**	19ME7T35
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Operations Research	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
To make the students learn about	
1	Classical optimization techniques
2	Numerical methods for optimization
3	Genetic algorithm and Genetic programming
4	Multi-Objective Genetic algorithm
5	Optimization in design and manufacturing systems

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Analyze the Classical optimization techniques for single and multi-variable problems with and with and without constraints.	K4
CO2	Apply numerical methods for optimization of manufacturing related problems	K3
CO3	Apply the Principles of genetic algorithm and genetic programming to manufacturing related problems	K3
CO4	Analyze the Multi-Objective Genetic algorithm for industrial problems	K4
CO5	Solve engineering problems by using optimization techniques in design and manufacturing systems	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	2	1	-	-	-	-	-	-	-	2	1
CO2	2	3	2	2	1	-	-	-	-	-	-	1	2	1
CO3	2	3	2	2	1	-	-	-	-	-	-	1	2	1
CO4	2	3	2	2	1	-	-	-	-	-	-	1	2	1
CO5	2	3	2	2	1	-	-	-	-	-	-	1	2	1

COURSE CONTENT

UNIT I

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

UNIT II

NUMERICAL METHODS FOR OPTIMIZATION: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of

penalty methods for handling constraints, advantages of numerical methods.

UNIT III

GENETIC ALGORITHM (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

GENETIC PROGRAMMING (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT IV

MULTI-OBJECTIVE GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.

UNIT V

APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

TEXT BOOKS

1. Engineering Optimization Theory & Practice, Singiresu S. Rao New Age International Publishers, Ltd.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI Publishers.

REFERENCE BOOKS

1. Genetic algorithms in Search, Optimization, and Machine learning, D.E.Goldberg, Addison-Wesley Publishers
2. Multi objective Genetic algorithms, Kalyanmoy Deb, PHI Publishers
3. Optimal design, Jasbir Arora, Mc Graw Hill (International) Publishers
4. Optimum Design of Mechanical Elements, Ray C. Johnson, John Wiley & sons, Inc., New York.

WEB RESOURCES

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://nptel.ac.in/courses/106/108/106108056/
3. https://nptel.ac.in/courses/112/105/112105235/
4. https://onlinecourses.nptel.ac.in/noc21_me43/preview
5. https://www.nptel.ac.in/content/syllabus_pdf/112103301.pdf

IV Year I Semester
GAS DYNAMICS & JET PROPULSION

Course Category	Professional Elective	**Course Code**	19ME7T36
Course Type	Theory	**L-T-P-C**	**3-0-0-3**
Prerequisites	Heat Transfer	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Student will learn	
1	Basic concept of gas dynamics
2	The Isentropic flow fundamentals
3	The compressible flow with friction and heat transfer
4	The effect of heat transfer on flow parameters.
5	The usage in jet air craft & aircraft propulsion systems and rocket propulsion and its applications.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain basic concepts of gas dynamics.	K2
CO2	Apply the steady one-dimensional isentropic flow.	K3
CO3	Apply the flow properties in an isothermal flow with friction.	K3
CO4	Explain the effect of heat transfer on flow parameters.	K2
CO5	Discuss propulsion in various aircrafts & rockets.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	3	1	2	1	--	--	--	--	--	1	1	1
CO2	2	--	3	1	2	--	--	--	--	--	--	--	2	--
CO3	3	2	3	2	1	--	--	--	--	--	--	--	2	--
CO4	3	2	3	2	1	--	--	--	--	--	--	--	2	1
CO5	2	1	3	2	3	--	--	--	--	--	--	--	1	2

COURSE CONTENT

UNIT-I

Introduction to gas dynamics: control volume and system approaches acoustic waves and sonic velocity - Mach number - classification of fluid flow based on mach number - mach cone- compressibility factor - general features of one-dimensional flow of a compressible fluid - continuity and momentum equations for a control volume.

UNIT-II

Isentropic flow of an ideal gas: basic equation - stagnation enthalpy, temperature, pressure and density-stagnation, acoustic speed - critical speed of sound- dimensionless velocity-governing equations for isentropic flow of a perfect gas - critical flow area - stream thrust and impulse function. Steady one-dimensional isentropic flow with area change-effect of area change on flow parameters- chocking-convergent nozzle - performance of a nozzle under decreasing back pressure -De level nozzle - optimum

area ratio effect of back pressure - nozzle discharge coefficients – nozzle efficiencies.

UNIT- III

Simple frictional flow: adiabatic flow with friction in a constant area duct governing equation - fanno line limiting conditions - effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct governing equations - limiting conditions.

Steady one dimensional flow with heat transfer in constant area ducts governing equations - Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy.

UNIT-IV

Effect of heat transfer on flow parameters: Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas- properties of flow across a normal shock - governing equations - Rankine Hugoniat equations - Prandtl's velocity relationship - converging diverging nozzle flow with shock thickness - shock strength.

UNIT- V

Propulsion: Air craft propulsion: - types of jet engines - energy flow through jet engines, thrust, thrust power and propulsive efficiency turbojet components-diffuser, compressor, combustion chamber, turbines, exhaust systems.

Performance of turbo propeller engines, ramjet and pulsejet, scramjet engines. Rocket propulsion - rocket engines, Basic theory of equations - thrust equation - effective jet velocity - specific impulse - rocket engine performance.

TEXT BOOKS:

1. Fundamentals of compressible flow with aircraft and rocket propulsion- S. M.Yahya
2. Compressible fluid flow - A. H.Shapiro.
3. Fundamental of Gas dynamics, 2nd edition– Zucker- Wileypublishers.

Data book: Compressible flow gas tables S. M. Yahya, New age international publications.

REFERENCE BOOKS:

1. Elements of gas dynamics - Liepman&Roshko.
2. Aircraft & Missile propulsion -Zucrow.
3. Gas dynamics - M.J. Zucrow& JoeD.Holfman.

WEB REFERENCES:

1. https://nptel.ac.in/courses/101/106/101106044/
2. https://nptel.ac.in/courses/112/106/112106166/

IV Year I Semester
MECHANICAL VIBRATIONS

Course Category	Professional Elective	**Course Code**	19ME7T37
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Dynamics of Machinery	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Students will learn	
1	The basic concepts of vibration in damped and undamped systems.
2	The concept of mode shapes of the two-degree freedom systems and have the knowledge of the various vibration measuring instruments.
3	The mode shapes of the multi degree freedom.
4	Learn to solve vibrations problems by various methods like Rayleigh's and stodola's.
5	The application of application concept of vibrations.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the various 1-D periodic and periodic responses of a vibrating system with and without damping	K2
CO2	Discuss the concepts of natural frequencies and mode shapes of the two-degree freedom systems.	K2
CO3	Express the numerical methods for multi degree freedom systems.	K2
CO4	Solve various numerical problems using various methods like Rayleigh's, stodola's	K3
CO5	Apply real life vibration data concepts during application.	K3

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	2	1	--	--	--	--	--	2	1	--
CO2	3	3	3	2	1	--	--	--	--	--	--	2	1	--
CO3	3	3	3	2	1	--	--	--	--	--	--	1	1	--
CO4	3	3	3	2	2	--	--	--	--	--	--	2	1	--
CO5	3	3	3	1	2	--	--	--	--	--	--	2	1	--

COURSE CONTENT

UNIT I

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility.

UNIT II

Vibration Measurement: Vibrometers, velocity meters & accelerometers

Two degree of freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT III

Multi degree of freedom systems: Matrix formulation, stiffness and flexibility influence coefficients;

Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

UNIT IV

Numerical Methods: Rayleigh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

UNIT V

Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

TEXT BOOKS

1. Elements of Vibration Analysis by Meirovitch
2. Mechanical Vibrations by G.K. Groover.

REFERENCE BOOKS

1. Vibrations by W.T. Thomson
2. Mechanical Vibrations – Schaum series.
3. Vibration problems in Engineering by S.P. Timoshenko

WEB RESOURCES

1. https://nptel.ac.in/courses/112/103/112103111/
2. https://nptel.ac.in/courses/112/103/112103112/

IV Year I Semester
DESIGN FOR MANUFACTURING

Course Category	Professional Elective	**Course Code**	19ME7T38
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Design of Machine Members, Production Technology, Metrology	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To familiarize with the design considerations for manufacturing and assembly.
2	To discusses capabilities and limitations of each manufacturing process in relation to part design and cost.
3	To learn how to analyze products and be able to improve their manufacturability and lower costs.
4	To understand the relationship between customer desires, functional requirements, product materials, product design, and manufacturing process selection.
5	To understand the concepts of extrusion and plastic components design process.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Apply the principles of design for manufacturing processes.	K3
CO2	Understand the design rules for machining and its recommendations.	K2
CO3	Analyze the metal casting processes and its simulation system in casting design.	K4
CO4	Identify the design factors for casting welding and forging.	K3
CO5	Understand the design guidelines for extrusion, sheet metal and non-metallic components.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	--	1	3	2	--	--	--	--	--	--	--	--	2	--
CO2	1	--	--	--	--	--	--	--	--	--	--	--	1	--
CO3	2	1	2	1	1	--	--	--	--	--	--	--	2	--
CO4	2	1	1	2	1	--	--	--	--	--	--	--	2	--
CO5	--	--	1	1	--	--	--	--	--	--	--	--	2	--

COURSE CONTENT

UNIT I

Introduction: Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production-creativity in design. Design for the life cycle total product life consumer goods –design considerations, Effect of manufacturing process on design, mechanisms selection, evaluation method.

Materials: Relation of Material selection to design and process, Process selection.

UNIT II

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining-ease-redesigning of components for machining ease with suitable examples, General design recommendations for machined parts, Design for

economy - Design for accessibility.

UNIT III

Metal casting: Appraisal of various casting processes, selection of casting process, -general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting. Design for assembly method- Dewhurst DFA method, Material selection process and economics of materials.

UNIT IV

Metal joining: Appraisal of various welding processes factors in design of weldments– general design guidelines pre- and post-treatment of welds- effects of thermal stresses in weld joints-design of brazed joints.

Forging: Design factors for forging– closed die forging design– parting lines of dies– drop forging die design– general design recommendations.

UNIT V

Extrusion & Sheet metal work: Design guide lines extruded sections- design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram– component design for blanking.

Non-Metallic Components Design: Viscoelastic and creep behaviour in plastics-design guidelines for plastic components-design considerations for injection moulding–design guidelines for machining and joining of plastics.

TEXT BOOKS

1. Design for manufacture & assembly (DFMA)-the Boothroyd & Dewhurst approach, I. Bettles, IET Publisher.
2. Design for Manufacturability Handbook, James Bralla, McGraw-Hill Professional
3. Engineering Design, George E. Dieter, Linda C. Schmidt, Boston: McGraw-Hill Higher Education, ©2009.

REFERENCE BOOKS

1. Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, O. Molloy, S. Tilley, E. Warman, Springer US.
2. Engineering Design - A Systematic Approach, Robert Matousek, Blackie & Sons Ltd, 1963.
3. Knowledge Based Design for Manufacture, Swift, K. G, Kogan Page Ltd., 1987.

WEB RESOURCES

1. http://www.npd-solutions.com
2. ASM HandbookVol.20
3. http://nptel.ac.in/courses/112101005/
4. http://nptel.ac.in/syllabus/syllabus_pdf/112101005.pdf
5. http://nptel.ac.in/courses/107103012/6
6. http://nptel.ac.in/syllabus/112101005/

IV Year I Semester
MANAGEMENT OF INVENTORY SYSTEMS

Course Category	Professional Elective	**Course Code**	19ME7T39
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Industrial Engineering and Management	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To Impart the knowledge on basic concepts used in inventory management techniques.
2	To understand the Classification of inventory problems in real time situations.
3	To Learn about Dynamic inventory problems under certainty.
4	To learn Various Dynamic inventory problems under risk and Uncertainty conditions are discussed.
5	To Study Current approaches in production and inventory management.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Describe the inventory management techniques and related fundamentals	K2
CO2	Analyze the concept of inventory in real time problems	K4
CO3	Evaluate the dynamic inventory problems under certainty conditions	K4
CO4	Evaluate the dynamic inventory problems under risk and uncertainty	K4
CO5	Analyze the modern production and inventory concepts and use them in inventory management and production.	K4

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	1	1	2	-	-	-	-	-	-	2	2
CO2	-	2	-	1	1	-	-	-	-	-	-	2	2	1
CO3	-	2	-	1	1	-	-	-	2	-	-	2	2	1
CO4	-	2	2	1	2	-	-	-	-	-	-	2	3	1
CO5	-	2	-	-	3	-	-	-	2	-	-	3	2	2

COURSE CONTENT

UNIT I

Introduction to inventory and Materials Management: Definitions, Need for inventory, Structure of inventory models, Nature of analysis, Relationships with other functions, inventory costs and their measurement. Types of inventory, Importance and areas of material management, selective inventory management techniques.

UNIT II

Classification of inventory problems:

Static inventory problems under risk: General characteristics, opportunity cost matrix and cost structure, Mathematical formulations (discrete and continuous cases), Imputation of costs, problem solving.

Static inventory problems under uncertainty: General characteristics, Decision criteria for uncertainty and inventory problems, Distribution free analysis (Tchebycheff and other inequalities), comparison of analyses with full and partial information, Problem solving.

UNIT III

Dynamic inventory problems under certainty: General characteristics, optimal lot size model (With constant and varying demand), Quantity discounts, optimal policy curve for more than one item, Solution techniques for multiple items, inventory problem formulation and solution under several types of constraints, Problem solving.

UNIT IV

Dynamic inventory problems under risk: General characteristics, types of inventory control systems, Switching matrices, optimal selling policy with fluctuating prices, Queuing model for varying lead time, Problem solving.

Dynamic inventory problems under uncertainty: General characteristics, Moments of convolutions, Design of Q- and P- system of inventory control, use of central ware houses, problem solving.

UNIT V

Design of inventory studies and Decision Procedures: Elements of inventory study, Approaches available, Size of inventory investment and number of items carried, System analysis with many items carried, Many locations, and many departments, System design by simulation, problem solving.

Current approaches: Concept of MRP and JIT based production systems, Concept of zero inventory, computerization of inventory and production management systems, other issues.

TEXT BOOKS

1. Inventory Control: Theory and Practice / Martin Starr K.K and D.W.Miller, Prentice hall.
2. Inventory management and production planning and Scheduling/ D.F.Pyke and R.Peterson, john willey.
3. Principles of Materials Management / Tersine R.J, ,Ptr Prentice Hall.

REFERENCE BOOKS

1. Scientific Inventory Management / Buchan J and E.Koenisberg, Prentice hall.
2. Material requirements planning / Orlicky, McGraw Hill.
3. Materials Management: An Integrated Approach / Gopalakrishnan p, and M.Sunderesan,PHI Publishers.
4. Purchasing: Principles and applications / Fareel and C.L.Smith, Prentice hall.

WEB RESOURCES

1. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg43/
2. https://onlinecourses.nptel.ac.in/noc21_mg23/preview
3. https://www.unleashedsoftware.com/inventory-management-guide/inventory-management-systems
4. https://www.unleashedsoftware.com/inventory-management-guide

IV Year – I Semester
CAD/CFD LABORATORY

Course Category	Lab Course	**Course Code**	19ME7L12
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	CAD/CAM	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES:	
Student will learn:	
1.	The Knowledge on 3D modeling software's and various Finite Element Analysis tools.
2.	To solve the Problems of fluid mechanics and heat transfer by writing programs with different forms of equations.
3.	To utilize the concept of ANSYS-FLUENT to acquire results.

COURSE OUTCOMES:		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Utilize the CAD tools, 3D modeling software's and various Finite Element Analysis tools.	K3
CO2	Solve the concept of CFD with different forms of equations.	K3
CO3	Make use of appreciate the utility of the tools like ANSYS- FLUENT in solving real time problems and day to day problems.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	3	-	-	-	2	-	-	-	3	3
CO2	3	3	3	2	3	-	-	-	2	-	-	-	3	3
CO3	3	3	3	2	3	-	-	-	2	-	-	-	2	2

LIST OF EXPERIMENTS:	
CAD LAB:	
1.	**DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric representation of dimensioning and tolerances scanning and plotting. Study of script, DXE and IGES files.
2.	**PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modeling

	surface and assembly modeling. Study of various standard translators. Design simple components. Generative drafting exercises.
3.	Import CAD model into analysis software and carry out the following:
	1. Determination of deflection and stresses in 2D and 3D trusses and beams.
	2. Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and Axisymmetric components.
	3. Determination of stresses in 3D and shell structures (at least one example in each case).
	4. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
	Steady state heat transfer Analysis of plane and Axisymmetric components
Packages to be provided to cater to drafting, modeling & analysis from the following: Micro Station, CATIA, Pro-E, I-DEAS, ANSYS, NISA, CAEFEM, ABACUS etc. Total 6 experiments to be conducted from the above mentioned 3 experiments.	
CFD LAB:	
PART-A	
1.	Solution of Transcendental equations.
2.	Solution of Simultaneous algebraic equations
3.	Numerical differentiation and Integration
4.	Solution of Ordinary Differential Equation
5.	Solution of Incompressible Navier-Stokes equations (Finite difference and Finite Volume methods)
6.	Solution of Inviscid incompressible fluid flows. (Finite difference and Finite Volume methods)
PART-B	
Using ANSYS-FLUENT solve the following problems of heat transfer analysis	
1.	Steady state conduction
2.	Lumped heat transfer
3.	Convective heat transfer – Internal flow (study both velocity and thermal boundary layers)
4.	Convective heat transfer – External flow (study both velocity and thermal boundary layers)
5.	Radiation heat transfer– Emissivity
Total 6 experiments to be conducted from any 3 experiments at each part.	

IV Year I Semester
CAM / MECHATRONICS LABORATORY

Course Category	Lab Course	**Course Code**	19ME7L13
Course Type	Laboratory	**L-T-P-C**	0-0-3-1.5
Prerequisites	CAD/CAM, Mechatronics	**Internal Assessment** **Semester End Examination** **Total Marks**	25 50 75

COURSE OBJECTIVES	
Students will learn	
1	Impart knowledge on G-codes and M-codes for CNC programming and to know various tools to be used to improve the products in industries.
2	The method of programming the microprocessor and also the design, modelling & analysis of basic electrical system which enable the students to understand the concept of mechatronics.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Develop CNC program for real time product manufacturing applications.	K3
CO2	Develop PLC programs for real time applications like control of traffic lights, water level, and lifts.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	3	2	3	0	0	0	1	0	0	1	2	3
CO2	1	2	3	2	3	0	0	0	1	0	0	1	2	3

COURSE CONTENT

LIST OF EXPERIMENTS

A. CAM Laboratory

1. Study of various pre/post processors used in CNC Machines.
2. Machining of simple components on CNC lathe and Mill by transferring CNC Code / from a CAM package.
3. CNC part programming Entry and Geometry.
4. Practices on CNC Turning Machine
    a. Programming for facing operation.
    b. Programming for turning operation.
    c. Programming for Linear and Circular interpolation.
    d. Programming for Facing Cycle.
    e. Programming for Multiple Facing Cycle.
    f. Programming for Grooving Cycle.
5. Practice on CNC Milling Machine
    a. Programming using linear and circular interpolation.
    b. Programming using Sub-Program.
    c. Programming for Mirroring Operation.
    d. Programming for Circular Pocket Milling operation.
    e. Programming for Rectangular Pocket milling operation.
    f. Programming for Drilling Operation

B. Mechatronics Laboratory

1. Introduction PLC Programming
2. Ladder programming on Logic gates, Timers & counters.
3. Ladder programming for Traffic Light control.
4. Ladder programming for Water level control.
5. Ladder programming for Lift control Modules.
6. Sample programme on MATLAB

Note: Total 10 experiments should be conducted from A & B.

IV Year II Semester
UNCONVENTIONAL MACHINING PROCESSES

Course Category	Professional Core	**Course Code**	19ME8T40
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Production Technology, Metal cutting and Machine tools	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	Understand the Need of unconventional machining processes and working of USM
2	Learn the working of electro chemical machining
3	Study the working of Thermal Metal Removal Processes
4	Learn the working of Electron Beam Machining, Laser Beam Machining
5	Understand the working of Abrasive jet machining, Water jet machining and abrasive water jet machining

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain unconventional machining processes and working of USM	K2
CO2	Explain the electro chemical machining processes	K2
CO3	Classify the operations performed in Thermal metal removal processes	K2
CO4	Recall operation of Electron Beam Machining, Laser Beam Machining	K1
CO5	Explain the processes of Abrasive jet machining, Water jet machining and abrasive water jet machining	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	--	1	--	--	--	--	--	--	--	--	1	1	--
CO2	2	--	1	--	--	--	2	--	--	--	--	1	1	--
CO3	2	--	1	--	--	--	--	--	--	--	--	1	3	--
CO4	2	--	--	--	--	--	--	--	--	--	--	1	3	--
CO5	2	--	--	--	--	--	2	--	--	--	--	1	2	--

COURSE CONTENT

UNIT I

INTRODUCTION: Need for non-traditional machining methods-classification of modern machining process – considerations in process selection, applications.

Ultrasonic machining – Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications and limitations.

UNIT II

ELECTRO – CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and de-burring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, fundamentals of chemical machining, advantages and applications.

UNIT III

THERMAL METAL REMOVAL PROCESSES: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface

UNIT IV

Electron Beam Machining, Laser Beam Machining - Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications Plasma Machining: Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

UNIT V

Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipments, process variables, mechanics of material removal, MRR, application and limitations, magnetic abrasive finishing, abrasive flow finishing, Electro stream drilling, shaped tube electrolytic machining.

TEXT BOOKS

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel –Gawad El-Hafy/CRC Press-2016.
2. Modern Machining Process / Pandey P.C. and Shah H.S./ TMH.

REFERENCE BOOKS

1. New Technology / Bhattacharya A/ the Institution of Engineers, India 1984.
2. Non Traditional Manufacturing Processes / Benedict

WEB RESOURCES

1. https://nptel.ac.in/courses/112/104/112104028/
2. https://nptel.ac.in/courses/112/103/112103202/

IV Year II Semester
COMPUTATIONAL FLUID DYNAMICS

Course Category	Professional Elective	**Course Code**	19ME8T41
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Thermodynamics, Fluid Mechanics and Heat Transfer	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn fundamentals of numerical techniques and error estimation using computational methods.
2	To learn the different methods to solve the system of simultaneous equations.
3	To solve the conduction and convection heat transfer problems using finite difference methods.
4	To learn the application of finite difference method to fluid flow problems.
5	To learn the modelling of fluid flow and finite volume method using various interpolations.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		Cognitive Level
CO1	Inference the effect of number systems and its representation and use appropriate computational method in error estimation.	K4
CO2	Analyze different computational methods and apply suitable method to solve system of simultaneous equations.	K4
CO3	Understand the governing equations and solve heat transfer problems using finite difference applications.	K3
CO4	Understand fluid flow modelling apply the physical principles to a suitable model of the flow.	K3
CO5	Explain finite volume methods for fluid dynamics.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	3	--	--	--	--	--	--	--	--	1
CO2	--	3	3	2	3	--	--	--	--	--	--	--	--	3
CO3	--	--	--	3	2	--	--	--	--	--	--	--	--	3
CO4	--	--	--	3	2	--	--	--	--	--	--	--	--	2
CO5	3	2	--	1	--	--	--	--	--	--	--	--	--	1

COURSE CONTENT

UNIT I

ELEMENTARY DETAILS IN NUMERICAL TECHNIQUES: Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, convergence of sequences.

UNIT II

APPLIED NUMERICAL METHODS: Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices.

REVIEW OF EQUATIONS GOVERNING FLUID FLOW AND HEAT TRANSFER: Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations, conservation of energy principle, and special forms of the Navier-stokes equations.

UNIT III

FLUID FLOW: Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation. Finite difference applications in heat conduction and convention - heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

UNIT IV

FLUID FLOW MODELLING: Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods. Introduction to first order wave equation, stability of hyperbolic and elliptic equations.

UNIT V

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

TEXT BOOKS

1. Numerical heat transfer and fluid flow, Suhas V. Patankar, Taylor & Francis Group, CRC press.
2. Computational fluid dynamics - Basics with applications, John. D. Anderson, Mc-Graw Hill.

REFERENCE BOOKS

1. Computational Fluid Flow and Heat Transfer, Niyogi, Pearson Publications
2. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.

WEB RESOURCES

1. https://nptel.ac.in/courses/112/105/112105045/
2. https://onlinecourses.nptel.ac.in/noc20_me64/preview

IV Year II Semester
MECHANICAL BEHAVIOUR OF MATERIALS

Course Category	Professional Elective	**Course Code**	19ME8T42
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Material Science and Metallurgy, Mechanics of Solids	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand the concepts of material science, arrangement of crystal structure and mechanical behavior of metals.
2	To learn the importance of elastic and plastic deformation of metals.
3	To learn theories of failures to predict failure of materials.
4	To understand the theory of fracture mechanics of materials and creep.
5	To learn about failure of materials due to fatigue loading and fatigue failure theories.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain the importance of materials in engineering field in relation with crystal structure and crystal imperfections.	K2
CO2	Interpret mechanical properties of materials and identify the quantitative relationships characterizing the properties of the materials.	K3
CO3	Understand the mechanism of failure of materials and apply specific failure theory for a particular application.	K3
CO4	Apply fracture models based on ultimate failure and fracture strengthening of materials and understand the creep mechanism.	K3
CO5	Determine cause of fatigue failure and evaluate solutions to prevent fatigue failure in accordance with empirical fatigue models.	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
CO2	1	--	--	--	--	--	--	--	--	--	--	--	--	--
CO3	2	2	1	1	--	--	--	--	--	--	--	--	1	--
CO4	2	2	1	1	--	--	--	--	--	--	--	--	2	--
CO5	1	2	2	1	1	--	--	--	--	--	--	--	2	--

COURSE CONTENT

UNIT I: Introduction: Introduction and classification of materials, Dislocations and strengthening mechanisms: Basic concepts, slip systems, slip in single crystals, critically resolved shear stress, plastic deformation in polycrystalline materials, deformation in twinning, strengthening mechanisms.

UNIT II: Mechanical properties of materials: Tensile test, compression test, shear and torsion test. Elastic deformation: Stress-strain plot, engineering and true stress-strain plots, relations between true and engineering values, Young's modulus, relation between elastic constants, Hooke's law.

Plastic deformation: yielding and yield strength, tensile strength, considere's criterion, ductility, resilience and toughness, elastic recovery.

UNIT III: Failure of Materials: Introduction, Stress concentration factors, Stress tensor and its invariants, Static failure theories.
Ductile materials: Tresca, Von-mises, Brittle materials: Maximum normal stress theory, Mohr-Coulomb, Modified Mohr-Coulomb, Factor of Safety, Application of failure theories

UNIT IV: Fracture Mechanics: Griffith criterion, Stress-intensity factor**,** Modes of crack extension**,** Fracture toughness, Creep**.** Applications.

UNIT V: Fatigue failure theories: Low cycle and high cycle fatigue, Stages of fatigue crack propagation, Stress-life approach and LEFM approach, types of fatigue loading, Rotating beam test and Marin factors, Endurance limit, Fatigue strength, effect of mean stress on fatigue life: Gerber parabola, Gough ellipse, Soderberg line, Modified Goodman diagram, Paris' law, Multiaxial fatigue

TEXT BOOKS

1. Thomas H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 2nd edition, 2013.
2. Mechanical Behavior of Materials, Marc Andre Meyers, Krishan Kumar Chawla, Cambridge University Press; 2nd edition, 2009.

REFERENCE BOOKS

1. Physical Properties of Crystals, J.F. Nye, Oxford University Press, 1972.
2. Introduction to Dislocations, D. Hull and D.J. Bacon, third edition, 1984.
3. Dislocations and Mechanical Behaviour of Materials, M.N. Shetty, PHI Learning Limited.

WEB RESOURCES

1. https://www.slideserve.com/chesna/mechanical-behavior-of-materials
2. https://www.powershow.com/view/59ef9-MjlmN/Mechanical_Behavior_of_Materials_powerpoint_ppt_presentation

IV Year II Semester
JOINING PROCESSES

Course Category	Professional Elective	**Course Code**	19ME8T43
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Production Technology	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To acquire the Knowledge on basics of Metal Joining processes
2	To understand the concept of Fusion welding and its classifications in detail.
3	To get basic idea on Modern Welding processes.
4	To understand the concept of resistance welding and its classifications.
5	To acquire the Knowledge on testing of welding joints and understand the concept of weldability.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain Metal joining processes used in welding of metals	K2
CO2	Select suitable Fusion welding process for joining of metals and alloys.	K3
CO3	Apply Modern welding techniques where traditional welding technology is not possible.	K3
CO4	Identify suitable Resistance welding depending upon the alloy of working.	K3
CO5	Identify suitable joining processes for dissimilar metals.	K3

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	1	-	2	-	-	-	-	-	1	1	1
CO2	3	2	2	1	2	-	-	-	-	-	-	1	1	1
CO3	3	3	2	1	3	1	-	-	-	-	1	1	1	2
CO4	3	2	2	1	-	-	-	-	-	-	-	1	1	1
CO5	3	3	2	1	2	1	-	1	-	-	-	1	1	1

COURSE CONTENT

UNIT I

Introduction of Metal Joining Processes:

Joining process as a manufacturing route. Relevance of joining process to metallurgy. Classification of joining process. Safety aspects in Metal joining processes, Advantages and Limitations of Metal joining processes, Applications of Joining processes.

UNIT II

Fusion welding:

Welding procedure, Joint design and edge preparation, welding codes for weld position. Welding symbols. Selecting groove geometry, fillet weld, bead weld, dilution, stress concentration, plug weld, weld bead geometry, Welding parameters, welding process, welding consumable, cleanliness, flux, electrode diameter.

SMAW: Function of coatings, based on slag metal, gas metal reactions- Coding Method (Specification) of consumable electrode & their functions. Selection Criteria for electrodes. AC, DCRP, DCSP configurations, Electrode shapes, polarity and its effects. Submerge arc welding, Electro -slag welding

Processes

GTAW, GMAW, FCAW Processes: GTAW welding Equipment, Non Consumable electrode, Inert Gases Process Parameters. Plasma Welding, type of guns. GMAW-Welding Equipment, Shielding gases, Process Parameters & different metals welded. FCAW-Welding equipment, Flux cored electrode wire & its functions.

UNIT III

Introduction to Modern Welding Processes

Electron beam welding, Laser beam welding, Explosive Welding, Atomic Hydrogen Welding. Thermit Welding, Ultrasonic welding, Under water welding, Industrial applications of Modern Welding Processes, Friction stir techniques for material processing, Friction Stir Welding, Friction stir processing, Friction stir Surfacing, Friction stir channeling etc. Use of Friction stir processing to increase Fatigue Resistance of Fusion Welds.

UNIT IV

Resistance welding:

Contact resistance, spot, seam projection, resistance butt, flash butt etc. Basic operational steps of Soldering & Brazing, different Soldering and Brazing Alloys, Role of Flux, Types of Flux, Metallurgical aspects of soldering and brazing. Applications of soldering and brazing in Engineering.

UNIT V

Weldability & Testing of Welded joints:

Weldability of Carbon steels, Stainless steels, Cast Iron, Aluminum & Titanium. Welding of dissimilar metals, repair welds, Welding defects, weld cracking Phenomena and its prevention. Review of Inspection and Mechanical testing of welded joints, Weld Solidification Cracking Susceptibility Test Methods.

TEXT BOOKS

1. Manufacturing Technology (Foundry, Forming and Welding), P.N.Rao, Tata Mc-Graw Hill
2. Modern Arc Welding Technology, S V Nadkarni, Ador Welding Limited
3. The Metallurgy of Welding, Brazing and Soldering, J.F. Lancaster, George Alien, Unwin Ltd.

REFERENCE BOOKS

1. Welding Technology, O.P. Khanna, Khanna Publications
2. The Physics of Welding, L.F.Lancaster, Pergamon Press.
3. Principles of Welding, R.S. Parmar
4. Friction Stir Welding and Processing, Rajiv S. Mishra & Murray W. Mahoney, ASM International

WEB RESOURCES

1. https://nptel.ac.in/courses/113/106/113106087/
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm06/

IV Year II Semester
PRODUCTION PLANNING AND CONTROL

Course Category	Professional Elective	**Course Code**	19ME8T44
Course Type	Theory	**L-T-P-C**	3-0-0-3
0Prerequisites	Industrial Engineering and Management	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To learn the concept of production and service systems
2	To understand the general principle techniques and types of forecasting
3	To learn the concept of inventory management.
4	To learn the principles of routing and it effect and methods of scheduling and controlling policies and aspects.
5	To understand dispatching procedures and role of computer in production planning and control.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Demonstrate various production and service systems in production planning and control.	K1
CO2	Summarize the concept of forecasting and their techniques.	K3
CO3	Recall the inventory management and its techniques.	K2
CO4	Utilize routing procedure, bill of material and scheduling processes and apply different scheduling and balancing techniques.	K4
CO5	Explain dispatching procedure and role of computer in production planning and control.	K2

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	2	1	1	--	--	--	--	--	--	--	1	1
CO2	--	3	2	2	1	--	--	--	2	1	1	--	3	2
CO3	--	3	2	--	1	--	--	--	2	1	1	--	1	1
CO4	2	3	2	2	1	--	--	--	2	1	1	--	3	2
CO5	2	2	2	1	1	--	--	--	2	--	--	--	1	1

COURSE CONTENT

UNIT I

INTRODUCTION: Definition – Objectives of production Planning and Control – Functions of production planning and control – Elements of production control – Types of production – Organization of production planning and control department – Internal organization of department – Product design factors – Process Planning sheet.

UNIT II

FORECASTING – Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques– qualitative methods and quantitative methods.

UNIT III

INVENTORY MANAGEMENT: Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P– Systems and Q-Systems. Introduction to MRP & ERP, LOB (Line of Balance), JIT inventory, and Japanese concepts, Introduction to supply chain management.

UNIT IV

ROUTING: Definition – Routing procedure – Route sheets – Bill of material – Factors affecting routing procedure. Scheduling – definition –Difference with loading.

SCHEDULING POLICIES: Techniques, Standard scheduling methods. Line Balancing, Aggregate planning, Chase planning, Expediting, controlling aspects.

UNIT V

DISPATCHING: Activities of dispatcher – Dispatching procedure –follow up – definition – Reason for existence of functions – types of follow up, applications of computer in production planning and control.

TEXT BOOKS

1. Elements of Production Planning and Control / Samuel Eilon.
2. Manufacturing, Planning and Control, Partik Jonsson Stig-Arne Mattsson, Tata Mc Graw Hill

REFERENCE BOOKS

1. Production Control A Quantitative Approach / John E. Biegel.
2. Baffa & Rakesh Sarin, ―Modern Production / Operations Management‖, 8th Edition, John Wiley & Sons, 2002.
3. Production Planning and Control – Text & cases/ SK Mukhopadhyaya/PHI.
4. Management Science- A R Aryasri-4e-TMH

WEB RESOURCES

1. https://nptel.ac.in/courses/112/107/112107143/
2. https://cosmolearning.org/video-lectures/mod-1-lec-1-production-planning-and-control-8823/
3. https://m.videoken.com/embed/9qBZyzjoqAo

IV Year II Semester
THERMAL EQUIPMENT DESIGN

Course Category	Professional Elective	**Course Code**	19ME8T45
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Heat Transfer	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
Students will learn	
1	Basic design of various types of heat exchangers and their working.
2	The Concepts of designing of double pipe heat exchanger.
3	The various concepts of designing heat exchangers based on constructional features.
4	The concepts on vaporizers, evaporators, reboilers and performance of cooling towers
5	The concepts on Direct Contact Heat Exchanger.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Explain different types of heat exchangers used industrial applications.	K2
CO2	Analyze the performance of double pipe exchanger based on direction of flow	K4
CO3	Analyze the performance of shell & tube heat exchangers	K4
CO4	Examine the performance of Vaporizers, Evaporators and Reboilers	K4
CO5	Analysis of cooling tower requirements	K4

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	-	-	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	1	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	-	-	3
CO4	1	3	3	2	-	-	-	-	-	-	-	-	-	3
CO5	2	1	1	2	-	-	-	-	-	-	-	-	-	2

COURSE CONTENT

UNIT I

Classification of heat exchangers: Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD & NTU method for heat exchanger analysis – parallel flow, counter flow, multipass, cross flow heat exchanger design calculations.

UNIT II

Double Pipe Heat Exchanger: Film Coefficient for fluids in annulus, fouling factors, calorific temperature, average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series-parallel arrangements.

UNIT III

Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers.

UNIT IV

Condensation of single vapours: Calculation of a horizontal condenser, vertical condenser, Desuper heater condenser, vertical condenser – sub-cooler, horizontal condenser – subcooler, vertical reflux type condenser, condensation of steam.

Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

UNIT V

Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, and calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance

TEXT BOOKS

1. Process Heat Transfer – D.Q. Kern, TMH.
2. Cooling Towers by J.D. Gurney

REFERENCE BOOKS

1. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York

WEB RESOURCES

1. https://onlinecourses.nptel.ac.in/noc21_ch18/preview
2. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ch18/

IV Year II Semester
ADVANCED MECHANICS OF SOLIDS

Course Category	Professional Elective	**Course Code**	19ME8T46
Course Type	Theory	**L-T-P-C**	**3-0-0-3**
Prerequisites	Mechanics of solids	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To understand the concept of theory of elasticity equations for solving various engineering problems
2	To study the failure modes of different structural members
3	To know about the internal stresses in curved beams and beams subjected to un-symmetrical bending.
4	To understand the deformations and stresses in non circular cross section members
5	To impart knowledge on deformations and stresses in non circular cross section members with torsional loading.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Understanding the basic concepts and solve simple problems of elasticity and plasticity.	K2
CO2	Solve the advanced practical problems related to the theory of elasticity, concepts of stress and strain, strain energy, and failure criteria.	K4
CO3	Analyze Propose materials and structural elements of complex structures	K4
CO4	Apply numerical methods to solve two dimensional problems of elasticity.	K3
CO5	Apply numerical methods to solve Torsion of Prismatic Bars.	K3

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	--	--	--	--	--	--	--	--	--	--	1	--
CO2	1	1	1	--	--	--	--	--	--	--	--	--	--	--
CO3	1	1	1	--	--	1	--	1	--	--	--	--	1	--
CO4	1	2	--	--	--	--	--	1	--	--	--	1	2	--
CO5	1	2	1	--	--	1	--	1	--	--	--	--	1	--

COURSE CONTENT

UNIT I

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

UNIT II

Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling. Application of energy

methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT III

Unsymmetrical bending: Bending stresses in Beams subjected to Non symmetrical bending; Deflection of straight beams due to non symmetrical bending.

UNIT IV

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT V

Torsion: Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hollow thin wall torsion members, Multiply connected Cross Section.

TEXT BOOKS

1. Advanced Mechanics of materials by Boresi& Sidebottom-Wiely International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition

REFERENCE BOOKS

1. Theory of Elasticity, Timoshenko S. and Goodier J. N., McGraw Hill, 1961.
2. Elasticity, Saddm. H., Elsevier, 2005.
3. Engineering Solid Mechanics, Ragab A. R., Bayoumis E., CRC Press,1999.
4. Computational Elasticity, Ameenm., Narosa,2005.
5. Solid Mechanics, Kazimis. M. A., Tata McGraw Hill,1994.
6. Advanced Mechanics of Solids, Srinath L. S., Tata McGraw Hill, 2007.

WEB RESOURCES

1. http://nptel.ac.in/
2. https://nptel.ac.in/content/storage2/courses/105106049/pdf-assignments/main.pdf
3. https://nptel.ac.in/courses/112/101/112101095/
4. https://nptel.ac.in/courses/105/104/105104160/
5. https://nptel.ac.in/courses/112/102/112102284/

IV Year II Semester
NON-DESTRUCTIVE EVALUATION

Course Category	Professional Elective	**Course Code**	19ME8T47
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Engineering Physics, Material Science and Metallurgy	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	To provide a basic understanding for inspecting materials in accordance with industry specifications and standards.
2	To introduce students to a variety of practical applications associated with ultrasonic testing
3	They will learn basic principles of NDE methods and will able to select a testing process
4	They will learn the magnetic particle testing techniques and their fundamental concepts
5	Be able to explain the purpose of the Equipment, Application, and standard techniques required to perform major non-destructive and destructive examinations of welds

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Understand the Radiography testing	K2
CO2	Apply the knowledge of Ultrasonic testing	K3
CO3	Understand the Liquid penetrant and Eddy Current Testing	K2
CO4	Analyze the magnetic particle testing techniques and their fundamental concepts	K4
CO5	Differentiate various defect types and select the appropriate NDT methods for better evaluation.	K5

K1: Remember, K2: Understand, K3: Apply, K4: Analyze, K5: Evaluate, K6: Create.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	--	1	--	2	--	--	--	--	--	--	--	--	2
CO2	2	--	1	--	3	--	--	--	--	--	--	--	--	2
CO3	2	--	2	--	3	--	--	--	1	--	--	--	1	2
CO4	2	--	1	--	2	--	--	--	1	--	--	--	1	2
CO5	2	2	2	--	3	--	--	--	1	--	--	--	1	2

COURSE CONTENT

UNIT I

Introduction to non-destructive testing: Visual Inspection. Radiography: Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

UNIT II

Ultrasonic test: Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect. Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method –A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications. Ultrasonic Transducers and their Characteristics

UNIT III

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure,

Effectiveness and Limitations of Liquid Penetrant Testing, Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT IV

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

UNIT V

Thermography: Thermography Principles, types, applications, advantages and limitations. Case studies: weld, cast and formed components**.**

Industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions

TEXT BOOKS

1. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011)
2. Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th edition (1989)

REFERENCE BOOKS

1. Non-destructive, Hand Book – R. Hamchand
2. Ultrasonic inspection training for NDT/ E. A. Gingel/Prometheus Press,

WEB RESOURCES

1. https://archive.org/details/nondestructivete000538mbp
2. http://www.issp.ac.ru/ebooks/books/open/Nondestructive_Testing_Methods_and_New_Applications.pdf

IV Year II Semester
FACILITIES LAYOUT AND DESIGN

Course Category	Professional Elective	**Course Code**	19ME8T48
Course Type	Theory	**L-T-P-C**	3-0-0-3
Prerequisites	Industrial Engineering and Management	**Internal Assessment** **Semester End Examination** **Total Marks**	30 70 100

COURSE OBJECTIVES	
1	The students will be able to select appropriate location for establishing industrial plants by applying the concepts of location selection.
2	The students will be able to plan and design plant layouts through basic strategies.
3	The students will be able to plan and design product layouts through basic strategies.
4	The students will be able to plan and design layouts through computer applications.
5	The students will be able to identify and optimize the problems in the existing layout/ material handling system.

COURSE OUTCOMES		
Upon successful completion of the course, the student will be able to:		**Cognitive Level**
CO1	Select the appropriate location for establishing industrial plant.	K2
CO2	Develop plant layouts through basic strategies	K3
CO3	Construct product layouts through basic strategies	K3
CO4	Model plant layout through computer applications.	K3
CO5	Illustrate the challenges in the existing material handling system and explain modern equipment used in material handling systems.	K2

K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO2	1	2	1	-	-	-	1	-	-	-	-	-	1	1
CO3	1	2	2	-	-	-	-	-	-	-	-	-	1	1
CO4	1	-	2	-	2	-	-	1	-	-	-	-	1	1
CO5	-	2	1	-	1	1	-	1	-	-	-	1	2	-

COURSE CONTENT

UNIT I

Introduction: Introduction to facilities planning and design, plant layout, material handling and their interrelationship.

Site Location: Importance of location, hierarchy of location problems, factors affecting site location; factors in heavy manufacturing location, light industry location, warehouse location, retail location. Various theories/models of site location like bid rent curves, Weber's isodapanes, Weber's classification of industries, Hoover's tapered transport rates, agglomeration, factor rating method, single facility location, load-distance model, break-even analysis, transportation method. New plant location and shut down under dynamic conditions.

UNIT II

Plant Layout: Objectives of a good plant layout, principles of a good layout, classical types of layouts like

product layout, process layout, fixed-position layouts, cellular layouts and hybrid layouts. Factors affecting plant layout: man, material, machine, movement, waiting, service, building and change, features and considerations of each factor. P - Q chart, systematic layout planning, relationship (REL) chart, traditional layout configuration, production space requirements, manual CORELAP algorithm and examples, preparing process layouts and the considerations thereon.

UNIT III

Product Layouts: basic features of mass manufacturing, advantages & disadvantages of flow-line production, product-oriented layout - assumptions & types, assembly line layout, assembly line balancing. Design of an assembly line, layout heuristics for assigning tasks in assembly line balancing, assembly line balancing equations.

UNIT IV

Computerized Layout: Evaluation of layout, computerized layout, flowcharts of various techniques like CRAFT, ALDEP and CORELAP.

UNIT V

Material Handling: Concept of material handling, principles of material handling, factors affecting material handling, objectives, material handling equation

Material Handling Equipment: Selection of material handling systems and equipment: Automated Guided Vehicles, types, features, usage. Conveyors: basic functionality requirements, types of Conveyors, application considerations, operational considerations. Cranes, hoists and industrial trucks.

TEXT BOOKS

1. James Apple, "Plant Layout & Material Handling", The Ronalt Press Co., New Delhi, 1998.
2. Francis, McGinnis and White, "Facilities Layout & Location -an analytical Approach" Prentice Hall of India Pvt Ltd., New Delhi, 2001.

REFERENCE BOOKS

1. Richards Muther, "Practical Plant Layout", McGraw Hill Book Co., New York, 1982.
2. Ronald H Ballou, "Business Logistics", Pearson Education, Inc. New Delhi, 2004.
3. Tompkins J A & J A White, "Facilities Planning", John Wiley & Sons, Inc. New York, 1984

WEB RESOURCES

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