Dr. Babasaheb Ambedkar Technological University, Lonere

(Established by Government of Maharashtra, vide Dr. Babasaheb Ambedkar Technological University Act. No XXIX of 2014)

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NEP 2020 BASED CURRICULUM

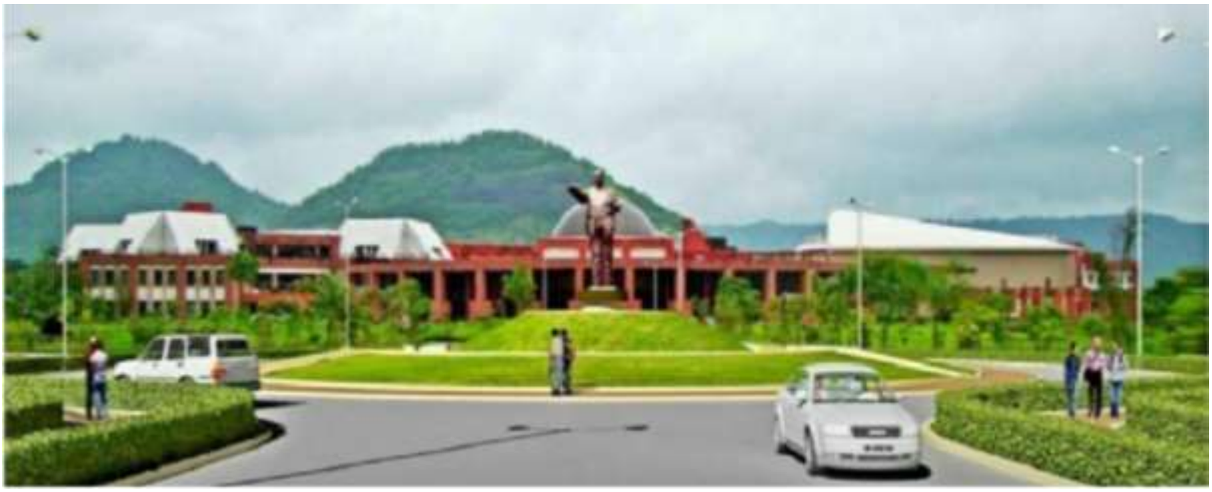
for

AFFILIATED COLLEGES

Third Year B. Tech. in

MECHANICAL ENGINEERING

ACADEMIC YEAR 2026-2027



	Vision	Mission
University	The University is committed to become a leading 'Center of Excellence' in the field of Engineering, Technology and Science as a seat of learning with a national character and international outlook.	The University is committed to provide quality technical education, research and development services to meet the needs of industry, business, service sector and society, at large.
Department of Mechanical Engineering	The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.	Imparting quality education, looking after holistic development of students and conducting need-based research and extension.

Graduate Attributes:

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** 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.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** 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.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with 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.
11. **Project Management and Finance:** 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.
12. **Life-long Learning:** Recognize 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 Educational Objectives (PEOs):

PEO1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO2	Graduates should excel in best post-graduate engineering institutes, reaching advanced degrees in engineering and related discipline.
PEO3	Within several years from graduation, alumni should have established a successful career in an engineering-related multi-disciplinary field, leading or participating effectively in interdisciplinary engineering projects, as well as continuously adapting to changing technologies.
PEO4	Graduates are expected to continue personal development through professional study and self-learning.
PEO5	Graduates are expected to be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes:

At the end of the program the student will be able to:

PO1	Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components and systems using state-of-the-art IT tools.
PO2	Analyze problems of production engineering including manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate production systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer-based-methods and tools to develop production systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

Credit Framework under Four-Years Under Graduate Engineering Programme with Multiple Entry and Multiple Exit options:

- The Four-year Bachelor's Multidisciplinary Engineering Degree Programme allows the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning from different institutions.
- The minimum and maximum credit structure for different levels under the Four-year Bachelor's Multidisciplinary Engineering Under-Graduate Programme with multiple entry and multiple exit options are as given below:

Credit Framework

Level	Qualification Title	Credit Requirement		Semester	Year
		Minimum	Maximum		
4.5	One-Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two-Years UG Diploma in Engg./Tech.	80	88	4	2
5.5	Three-Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor	160	176	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech. - Honors with Research and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech. - Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180	194	8	4

- There are multiple exit options at each level. The students will be given a specific Qualification mentioned in the table depending on the level at which he/she decides to have an exit, e.g., if a student decides to exit after completion of two years (level 5.0) of the program, he/she will be given a Diploma in Engineering with specific exit condition mentioned in the syllabus of the specific branch. He/she can rejoin the program with the multiple entry option at the level next where he/she chose to exit previously. The student can join at level 5.5 if successfully completed level 5.0 previously at the time of exit.
- Minimum credit requirements of each level are mentioned in the credit framework table.
- There are **4 distinct options available at level 6.0.**
- **First one is basic level 6.0 option** where minimum 160 - maximum 176 credits are mandatory which can be completed as per the Semester-wise Credit distribution structure mentioned in the table given below.

  Here, the Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (160 - 176 Credits) i.e. **B. Tech. in Mechanical Engineering with Multidisciplinary Minor** (160 - 176 credits) enables students to take up five-six or required additional courses of 14 credits in the discipline other than Mechanical Engineering distributed over semesters III to VIII. Here in the case of **B. Tech. in Mechanical Engineering with Multidisciplinary Minor** (160 - 176 credits) student is supposed to take up 50% or more Core Courses (mandatory courses, electives, vocational courses, Internship/ Field Projects/ Apprenticeship/Community Engagement Projects, Seminars, and Group Discussions) **from Mechanical Engineering discipline** to complete the 50% or more credits. In addition, the student will have to earn minimum 14 credits from the **multidisciplinary minor bucket**.
- Remaining three level 6.0 options are the advanced options where the student is given an opportunity to get extra qualification by earning some extra credits (18 - 20 extra credits). **These three options are given below:**
  1. Level 6.0: The **Bachelor's Engineering Degree with Honours** in chosen Major Engg./ Tech. Discipline i.e. in Mechanical Engineering with Honours with Multidisciplinary Minor (180 - 194 credits) enables students of Mechanical Engineering to take up five to six additional courses of 18 to 20 credits in the Mechanical Engineering discipline distributed over semesters III to VIII. The mechanism of distribution of these 18 - 20 credits over semesters III to VIII, which are over and above the 160 - 176 Credits prescribed for the duration of four years will be as prescribed by the University from time to time. The **student must have CGPA equal to or greater than 7.5 at the end of second semester to be eligible for this option**.
  2. Level 6.0: **The Bachelor's Engineering Degree with Research** in i.e., in Mechanical Engineering with Research with Multidisciplinary Minor (180 - 194 credits) enables students of Mechanical Engineering to take up a research project of 18 to 20 credits in the Mechanical Engineering discipline

distributed over the semesters VII to VIII. The **student must have CGPA equal to or greater than 7.5 at the end of sixth semester to be eligible for this option**.

3. Level 6.0: The **Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor** (Multidisciplinary Minor and Specialization Minor, 180 - 194 credits), i.e. **B. Tech. in Mechanical Engineering with Multi-disciplinary Minor and with Specialization Minor in Computer Engineering** (180 - 194 credits) enables students to take up five-six additional courses of 14 credits in the discipline other than Mechanical Engineering (for the completion of multidisciplinary minor) and 18 to 20 extra credits in the **Computer Engineering discipline** distributed over semesters III to VIII. Here, the ***other selected discipline*** **in Engineering should be different from Specialization Minor i. e. Computer Engineering**. This enables students to take up five-six or required additional courses of 18 to 20 credits in the **Computer Engineering** discipline distributed over semesters III to VIII, which are over and above the min.160 - max.176 Credits. The mechanism of distribution of these 18 - 20 credits over the semesters III to VIII, prescribed for the duration of four years will be as prescribed by the University from time to time. **The student must have CGPA equal to or greater than 7.5 at the end of second semester to be eligible for this option**.

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

It is necessary to follow the Semester-wise Credit distribution structure for Four-year UG Engineering Program as prescribed above.

- There are seven vertical categories with specific credits distributed in specific semesters.
- Student can choose a Program Elective Course (PEC) in that specific semester from the given subjects.
- Multidisciplinary course (MDM) and Open Elective (OE) courses can be chosen from the MDM and OE Buckets depending on student’s choice. Completion of total credits given in the last column of the table for each vertical is mandatory.
- The students can complete 40% of the courses through online platforms like

NPTEL/SWAYAM. The NPTEL/SWAYAM course content should be at least 80% similar to the course content in the syllabus.

General Rules and Regulations:

1. The normal duration of the course leading to B. Tech. degree will be EIGHT semesters.
2. The normal duration of the course leading to M. Tech. degree will be FOUR semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. For the First year B. Tech. and M. Tech. Classes, the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra-curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

Registration:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PG Programme:
   A full-time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.
2. Mandatory Pre-Registration for higher semesters: In order to facilitate proper planning of the academic activities of a semester, it is essential for every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/ PhD courses and the corresponding rules of evaluation will apply.
4. Under-Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the Departmental Under-Graduate Committee (DUGC) / Departmental Post-Graduate Committee (DPGC) is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfils the following conditions:
   i) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
   ii) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
   iii) Paid all required advance payments of the Institute and hostel for the current semester;
   iv) Not been debarred from registering on any specific ground by the Institute.

Evaluation System:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2023-24, from the first year B. Tech.

Percentage of Marks	**Letter Grade**	**Grade Point**
91 - 100	EX	10.0
86 - 90	AA	9.0
81- 85	AB	8.5
76 - 80	BB	8.0
71 - 75	BC	7.5
66 - 70	CC	7.0
61 - 65	CD	6.5
56 - 60	DD	6.0
51 - 55	DE	5.5
40 - 50	EE	5.0
<40	FF	0.0

2. Class is awarded based on the CGPA of all eight semesters of B. Tech. Program.

CGPA	**Class**
5.00 to 5.49	Pass class
5.50 to 5.99	Second Class
6.00 to 7.49	First Class
7.5 and above	Distinction
[Percentage of Marks = (CGPA - 0.5)*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

Mid Semester Exam (MSE) Marks	20
Continuous Assessment Marks	20
End Semester Examination (ESE) Marks	60

4. A total of 100 Marks for each practical course are distributed as follows:

Continuous Assessment Marks	60
End Semester Examination (ESE) Marks	40

- It is mandatory for every student of B. Tech. to score a minimum of 40 marks out of 100, M. Tech. to score a minimum of 45 marks out of 100 with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.
- This will be implemented from the first year of B. Tech. starting from Academic Year 2023-24.

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.

EE Grade: The 'EE' grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance.

6. Evaluation of Performance

a. **Semester Grade Point Average (SGPA)**

The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPA is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{\left[\sum_{i=1}^{n} c_i g_i\right]}{\left[\sum_{i=1}^{n} c_i\right]}$$

where,

'n' is the number of subjects for the semester,

'c_i' is the number of credits allotted to a particular subject, and

'g_i' is the grade-points awarded to the student for the subject based on his/her performance as per the table **given in point No. 1.**

SGPA will be rounded off to the second place of decimal and recorded as such.

b. **Cumulative Grade Point Average (CGPA):**

An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (up to two decimal places). Starting from the first semester at the end of each semester (S); a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{\left[\sum_{i=1}^{m} c_i g_i\right]}{\left[\sum_{i=1}^{m} c_i\right]}$$

where,

m is the total number of subjects from the first semester onwards up to and including the semester S,

c_i is the number of credits allotted to a particular subject, and

g_i is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

7. Attendance Requirements:

a. All students must attend every lecture, tutorial and practical classes.

b. To account for approved leave of absence (e.g. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted. If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination. The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be. In any case, the student will not be permitted for appearing the examination if the attendance is less than 65%.

c. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

d. The attendance records are to be maintained by the course instructor and s/he shall show it to the student, if and when required.

8. Transfer of Credits:

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.
b) Credits transferred will be considered for overall credits requirements of the programme.
c) Credits transfer can be considered only for the course at same level i.e. UG, PG etc.
d) A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. S/he shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to the Dean, Academics for approval.
e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.
f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.
g) In exceptional cases, the students may opt for higher credits than the prescribed.

Sem V (with effect from AY 2026-27)

Category under NEP	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
PCC		Applied Thermodynamics	2	1	-	20	20	60	100	3
PCC		Production Processes- II	3	-	-	20	20	60	100	3
PCC		Theory of Machines- I	2	1	-	20	20	60	100	3
PCC		Metrology & Quality Control	3	-	-	20	20	60	100	3
MDM		MDM**	3	-	-	20	20	60	100	3
PEC		Engineering Tribology	3	-	-	20	20	60	100	3
		Fluid Machinery								
		Sheet Metal Processing								
		Engineering Economics								
		Automobile Engineering								
VSEC		Applied Thermodynamics Lab	-	-	2	60	-	40	100	1
VSEC		Theory of Machines – I Lab	-	-	2	60	-	40	100	1
		Metrology Lab	-	-	2	60	-	40	100	1
VSEC		Seminar	-	-	2	60	-	40	100	1
OJT		Field /Industrial Training –I (To be started)	-	-	-	-	-	-	-	-
		Total	**16**	**2**	**8**	**360**	**120**	**520**	**1000**	**22**

MDM to be offered to other departments: Manufacturing Processes/ Fluid Mechanics

MDM** (the students will have to choose the MDM course being offered by other disciplines available/offered at the college)

Sem VI (with effect from AY 2026-27)

Category under NEP	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
PCC		Heat Transfer	2	1	-	20	20	60	100	3
PCC		Theory of Machines- II	3	-	-	20	20	60	100	3
PCC		Machine Design-I	2	1	-	20	20	60	100	3
PCC		Mechatronics	3	-	-	20	20	60	100	3
MDM		MDM**	3	-	-	20	20	60	100	3
PEC		Finite Element Method	3	-	-	20	20	60	100	3
		Product Life-cycle Management								
		Robotics								
		IC Engines								
		Computational Fluid Dynamics								
VSEC		Theory of Machines- II Lab	-	-	2	60	-	40	100	1
VSEC		Machine Design Practice - I	-	-	2	60	-	40	100	1
VSEC		Heat Transfer Lab	-	-	2	60	-	40	100	1
VSEC		Mechatronics Lab	-	-	2	60	-	40	100	1
CEP		Technical Project Related to Community Services	-	-	2	60	-	40	100	1
OJT		Field /Industrial Training –I (To be completed)	-	-	-	-	-	-	-	-
		Total	**16**	**2**	**10**	**420**	**120**	**560**	**1100**	**23**

MDM to be offered to other departments: Theory of Machines/ Automobile Engineering

Exit Option-III: Qualifier for UG Bachelor’s Degree

A project should be carried out in the areas of Manufacturing/ Thermal/ Design

- To be completed during vacation after third year in the industry/institute.
- This should contain the well-defined project activity which is equivalent to 12 Credits.
- It should be carried out for the duration of 12 Weeks.
- The project should be evaluated by a panel of examiners.

Course Code:
Course Title: Applied Thermodynamics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week Tutorial: 1 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

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

CO1	Understand the fundamentals of fuels, combustion, and steam generation systems
CO2	Analyze the performance of gas power cycles and vapour power cycles.
CO3	Understand the construction and working principles of boilers, steam nozzles, steam turbines, condensers, and cooling systems.
CO4	Evaluate the performance characteristics of steam nozzles, condensers, and steam turbines.
CO5	Analyze the working and performance of reciprocating and rotary air compressors.

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	1	-	-	-	-	-
CO2	3	3	2	2	1	-	1	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	-
CO4	3	3	2	2	1	-	-	-	-	-	-	-
CO5	3	3	2	1	2	-	1	-	-	-	-	-
CO6	2	2	1	1	3	2	3	-	-	-	-	2

Course Contents

Unit 1: Fuels and Combustion
Types of fuels, calorific values of fuel and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis.

Unit 2: Steam Generator
Classification of boilers, boiler details, Working principle of boiler, requirements of a good boiler; merits and demerits of fire tube and water tube boilers, boiler mountings and accessories.

Boiler Draught: Classification of draught, Chimney height calculation, efficiency of the chimney, draught losses.

Performance of Boilers: Equipment evaporation, boiler efficiency, boiler trial and heat balance, Waste heat recovery, Introduction to IBR.

Unit 3: Vapor and Gas Power Cycle
Ideal Rankine cycle, Reheat and Regeneration, specific steam/fuel consumption, work

ratio, Otto cycle, Diesel cycle, Stirling cycle, Joule-Brayton cycle.

Unit 4: Steam Nozzle, Condensers Steam Turbine

Steam Nozzles: Types of Nozzles, flow of steam through nozzles, General relationship between area, velocity and pressure, condition for maximum discharge, expansion of steam considering friction, super saturated flow through nozzles.

Condensers and Cooling Towers: Elements of steam condensing plants, advantages of using condensers, types of condensers, thermodynamic analysis of condensers, efficiencies, cooling towers.

Steam Turbines: Advantages and classification of steam turbines, compounding of steam turbines, velocity diagrams, work one done and efficiencies, losses in turbines.

Unit 5: Reciprocating Air Compressor
Classification constructional details, theoretical and actual indicator diagram, FAD, multi staging, condition for maximum efficiency, capacity control.
Rotary Compressor – Concepts of Rotary compressors, Root-blower and type compressors, Centrifugal compressors. introduction to slip factor.

Texts:

1. T. D. Eastop, A. McConkey, “Applied Thermodynamics”, Addison Wesley Longman.
2. Rayner Joel, “Basic engineering Thermodynamics”, Addison Wesley Longman.
3. Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, Wiley India Publications.

References:

1. Yunus A. Cengel, “Thermodynamics- An Engineering Approach", Tata McGraw Hill Publications.
2. P. K. Nag, “Basic and Applied Thermodynamics", Tata McGraw Hill Publications.
3. P. K. Nag, “Power Plant Engineering”, Tata McGraw Hill Publications, 2nd edition.
4. Sharma and Mathur, “Internal Combustion Engines”, Tata McGraw Hill Publications.

Course Code:
Course Title: Production Processes - II

Teaching Scheme	Examination Scheme
Lecture: 3 hrs /week Tutorial: -- Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration: 3 Hours)

Pre-Requisites: Production Processes - I

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

CO1	Understand the mechanics of metal cutting w.r.t. orthogonal and oblique cutting
CO2	Analyze the machinability of materials
CO3	Illustrate the mechanism of abrasive processes
CO4	Identify the various operations involved in the powder metallurgy
CO5	Compare various polymer processing techniques.

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1								
CO2	3	2	1	1	1		1					
CO3	3	1	1	1								
CO4	3	1	1	1			1					
CO5	3	2	1	1								

Course Contents

Unit 1: Mechanics of Metal Cutting

Geometry of single point cutting tools, terms and definitions; chip formation, forces acting on the cutting tool and their measurement; specific cutting energy; plowing force and the "size effect"; mean shear strength of the work material; chip thickness; shear angle theories: Merchant and Lee & Shaffer, friction in metal cutting.

Unit 2: Thermal aspects, Tool wear, and Machinability

Temperature in Metal Cutting: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures.

Tool life and tool wear: progressive tool wear; forms of wear in metal cutting: crater wear, flank wear, tool-life criteria; **Cutting tool materials:** Basic requirements of tool materials, major classes of tool materials: high speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings. Work material and machinability rating; Cutting fluids.

Unit 3: Abrasive Machining and Finishing Operations

Introduction; Abrasives and Bonded Abrasives: Grinding Wheels, Bond Types, Wheel Grade and

Structure; Grinding Process and its parameters: Grinding forces, specific energy, and temperature; Grinding-wheel wear, Grinding Ratio, Dressing, Truing and Shaping of Grinding Wheels, Grindability of Materials and Wheel Selection; Grinding Operations and Machines, Finishing Operations: Honing, lapping, and superfinishing.

Unit 4: Processing of Powder Metals

Introduction; Production of Metal Powders: Methods of Powder Production, Particle Size, Shape, and Distribution, Blending Metal Powders; Compaction of Metal Powders: Equipment, Isostatic Pressing, Sintering; Secondary and Finishing Operations.

Unit 5: Processing of Polymers

Introduction; Extrusion: Miscellaneous Extrusion Processes, Production of Polymer Reinforcing Fibers; Injection Molding: Reaction-injection Molding; Blow Molding; Rotational Molding; Thermoforming; Compression Molding; Transfer Molding; Processing Elastomers.

Texts:

1. Serope Kalpakjian and Steven R. Schmid, “Manufacturing Engineering and Technology”, Addison Wesley Longman (Singapore) Pte. India Ltd., 6th edition, 2009.
2. Geoffrey Boothroyd, Winston Knight, “Fundamentals of Machining and Machine Tools”, Taylor and Francis, 3rd edition, 2006.

References:

1. Milkell P. Groover, “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Paul DeGarmo, J. T. Black, Ronald A. Kohser, “Materials and Processes in Manufacturing”, Wiley, 10th edition, 2007.
3. M. C. Shaw, “Theory of Metal Cutting”, Oxford and I.B.H. Publishing, 1st edition, 1994.

Course Code:
Course Title: Manufacturing Processes

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs /week Tutorial: -- Credits: 3	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks (Duration: 3 Hours)

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

CO1	Remember the fundamental concepts of manufacturing, metal casting methods and typical casting defects.
CO2	Understand the principles and working of metal forming processes such as rolling, forging, extrusion, and drawing, along with their defects.
CO3	Select appropriate joining technique(s) for a given application
CO4	Identify turning and various hole-making operations.
CO5	Compare milling, broaching, and gear machining processes

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1		1	1				1		1
CO2	2	2	1		1	1				1		1
CO3	2	1	1		1	1				1		1
CO4	1		1		1	1				1		1
CO5	2		1		1	1				1		1

Course Contents

Unit 1: Introduction and Casting Processes

What is manufacturing? Selection of manufacturing processes, introduction to casting, metal casting process: sand casting; shell molding; investment casting; permanent-mold casting, casting defects.

Unit 2: Metal Forming

Rolling and Forging Processes:

Introduction to rolling, flat-rolling process, defects in rolled plates and sheets, rolling mills, various rolling processes.

Introduction to forging, open-die forging, impression-die and closed-die forging, various forging operations, forging defects.

Extrusion and Drawing:

Introduction to extrusion process, hot extrusion, cold extrusion, extrusion defects. Introduction to drawing process, drawing practices, drawing defect.

Unit 3: Joining Processes

Arc welding processes: Shielded metal arc welding; MIG; TIG; submerged arc welding, Gas welding processes: oxy-fuel-gas welding; advanced welding methods: electron beam welding; laser beam welding; Other joining processes: brazing; soldering and mechanical fastening.

Unit 4: Machining Processes: Turning and Hole Making

Introduction to turning process, lathes and lathe operations, lathe components, types of lathes. Hole making operations: Boring, drilling, reaming, and tapping.

Unit 5: Machining Processes: Milling, Broaching and Gear Manufacturing

Introduction to milling and milling machines, milling cutters, broaching and broaching machines, gear manufacturing by machining: form cutting, gear generating.

Texts:

1. Serope KalpakJian and Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 6th edition, 2009.

References:

1. Milkell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Paul DeGarmo, J.T. Black, Ronald A. Kohser, "Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.

Course Code:
Course Title: Theory of Machines - I

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hrs/week Credit: 03	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mechanics

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

CO1	Define basic terminology of kinematics of mechanisms
CO2	Classify planar mechanisms and calculate its degree of freedom
CO2	Perform kinematic analysis of a given mechanism using various methods
CO4	Understand role of friction & lubrication with their types.
CO5	Study various types cams, follower & follower motions.
CO6	Perform balancing of unbalance forces in rotating masses, different types of single/multi cylinder reciprocating engines in different positions.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents

Unit 1: Introduction
Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom.
Study of various mechanisms such as straight-line mechanisms, pantograph, Geneva mechanism, steering gear mechanisms.

Unit 2: Velocity & Acceleration Analysis
Instantaneous centre of rotation, body and space centrodes, Kennedy’s theorem.
Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using relative velocity method, Corioli’s component of acceleration.
Velocity and acceleration of slider crank mechanism by analytical method and Klein’s construction.

Unit 3: Friction and Lubrication

Dry friction, friction between nut and screw with different types of threads, Uniform wear theory and uniform pressure theory, Frication at pivot and collars, Friction in turning pair, Friction circle and friction axis, Friction in mechanisms.

Lubrication, Viscosity, Viscous flow, Boundary lubrication, Thick film lubrication, Hydrostatic and hydrodynamic lubrications.

Unit 4: Cams and Followers

Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion, Circular arc cam, Tangent cam, Cycloidal cam.

Unit 5: Balancing

Balancing of rotating masses in one and several planes, balancing of reciprocating, masses in single and multi-cylinder engine viz., inclined, radial and v-type engines, Primary and secondary balancing analysis, Concept of direct and reverse cranks, Balancing of locomotive engines, Effect of partial balancing, Static and dynamic balancing.

Texts:

1. A. Ghosh, A. K. Malik, "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
2. S. S. Rattan, "Theory of Machines", Tata McGraw Hill, New Delhi.

References:

1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi.
2. J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995.

Course Code:
Course Title: Metrology and Quality Control

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration: 3 Hours)

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

CO1	Identify techniques to minimize the errors in measurement
CO2	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Select quality control techniques and its applications
CO6	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1				3								2
CO2		2	2		2							
CO3			2	3	2							
CO4						3						
CO5	1					2		3	3		3	2
CO6	1					2		3	3		2	2

Course Contents

Unit 1: Measurement Standard and Comparators

Introduction to Metrology, Importance and Scope, Measurement Standard, Line, end and wavelength, Traceability of Standards, Calibration of Instruments. Types and Sources of error, Linear measurement (Vernier Calipers, Micrometers, slip gauges) and Angular Measurement (Bevel Protector, Sine bar, Sine center). Comparators: Mechanical, Pneumatic, and Electrical (LVDT).

Unit 2: Interferometry, Surface Finish and Limits, Fits, Tolerances

Principles of interference, Concept of flatness, Flatness testing, Optical flats.

Optical Interferometer and Laser interferometer.

Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Analysis of Surface Traces.

Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.

Unit 3: Metrology of Screw Thread and Gear
Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier, gear rolling tester Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Unit 4: Introduction to Quality and Quality Tools
Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brainstorming, Quality circles.

Unit 5: Total Quality Management and Statistical Quality Control
Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects. **Statistical Quality Control:** statistical concept, Frequency diagram, Concept of Variance analysis, Control chart for variable & attribute, Process Capability. Acceptance Sampling: Sampling Inspection, sampling methods.
Introduction to ISO 9000: Definition and aims of standardizations, Techniques of standardization, Codification system.

Texts:

1. I. C. Gupta, "Engineering Metrology", Dhanpatand Rai Publications, New Delhi, India.
2. M. S. Mahajan, "Statistical Quality Control", Dhanpat and Rai Publications.

References:

1. R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.
2. K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.
3. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.
4. K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, "Metrology & Measurements", Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7. Amitava Mitra, "Fundamental of Quality Control and Improvement", Wiley Publication.
8. V. A. Kulkarni, A. K. Bewoor, "Quality Control", Wiley India Publication.
9. Richard S. Figliola, D. E. Beasley, "Theory and Design for Mechanical Measurements", Wiley India Publication.
10. E. L. Grant, "Statistical Quality Control", Tata McGraw Hill Publications.
11. J. M. Juran, "Quality Planning and Analysis", Tata McGraw Hill Publications.

Course Code:
Course Title: Engineering Tribology

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

CO1	Understand basic concepts of tribology and surface interactions
CO2	Analyze friction mechanisms and influencing factors
CO3	Apply lubrication principles in engineering systems
CO4	Analyze wear mechanisms and evaluate material performance
CO5	Apply tribological design principles for material and bearing selection

Mapping of course outcomes with program outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1								1
CO2	3	3	1	2	1							1
CO3	3	3	2	2	2							1
CO4	3	3	2	3	1							1
CO5	3	3	3	2	2	1	2				1	2

Course Contents

Unit 1: Introduction
Definition of tribology, friction, wear and lubrication; importance of the tribological studies. Surface Topography: Methods of assessment, measurement of surface roughness- different statistical parameters (R_a, R_z, R_{max}, etc.), contact between surfaces, deformation between single and multiple asperity contact, contact theories involved

Unit 2: Friction
Coulomb and Amontons laws of friction, its applicability and limitations, comparison between static, rolling and kinetic friction, friction theories, mechanical interlocking, molecular attraction, electrostatic forces and welding, shearing and ploughing, models for asperity deformation.

Unit 3: Lubrication
Types of lubrication, viscosity, characteristics of fluids as lubricant, hydrodynamic lubrication, Reynold’s equation, elasto-hydrodynamic lubrication: partial and mixed, boundary lubrication, various additives, solid lubrication.

Unit 4: Wear
Sliding wear: Abrasion, adhesion and galling, testing methods pin-on-disc, block-on-ring, etc., theory of sliding wear, un-lubricated wear of metals, lubricated wear of metals, fretting wear of metals, wear of ceramics and polymers. Wearing by plastic deformation and brittle fracture. Wear by hard particles: Two-body abrasive wear, three-body abrasive wear, erosion, effects of hardness shape and size of particles.

Unit 5: Tribological Design and Bearing Materials

Wear rate estimation, System approach in tribodesign, reducing wear (operating parameters), Material selection and surface engineering, Bearings: Rolling bearings, Fluid film bearings, Dry and marginally lubricated bearings, Gas bearings

Texts:

1. I. M. Hutchings, “Tribology, Friction and Wear Engineering Materials”, Edward Arnold, London.
2. R. C. Gunther, “Lubrication”, Baily Brothers and Swinfen Limited.
3. F. T. Barwell, “Bearing Systems, Principles and Practice”, Oxford University Press.

References:

1. B. C. Majumdar, “Introduction to Tribology of Bearings”, A. H. Wheeler & Co. Private Limited, Allahabad.
2. D. F. Dudley, “Theory and Practice of Lubrication for Engineers”, John Willey and Sons.
3. J. Halling, “Principles of Tribology”, McMillan Press Limited. 124
4. Cameron Alas Tair, “Basic Lubrication Theory”, Wiley Eastern Limited.
5. M. J. Neale, “Tribology Hand book”, Butterworth’s. 6. D. D. Fuller, “Lubrication”.

Course Code:
Course Title: Fluid Machinery

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand and apply momentum equation
CO2	Understand and explain Hydrodynamic Machines
CO3	Explain difference between impulse and reaction turbines
CO4	Find efficiencies, draw velocity triangles
CO5	Explain governing mechanisms for hydraulic turbines
CO6	Explain working of various types of pumps, draw velocity diagrams, do simple Calculations
CO7	Design simple pumping systems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	1	-	-	-	-	-	-	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	3	2	2	2	-	-	-	-	-	-	-
CO5	3	2	2	1	1	-	1	-	-	-	-	-
CO6	3	3	2	2	2	-	1	-	-	-	-	-
CO7	3	3	3	2	2	1	2	-	-	-	1	1

Course Contents

Unit 1: Momentum Equation and its Applications
Impulse momentum, Principle, Fixed and moving flat inclined plates, Curved vanes, Series of plates and vanes, Velocity triangle and their analysis, Water wheels.

Fundamentals of the Hydrodynamic Machines
Classification, General theory, Centrifugal head, Fundamental equations, and Euler's equation, Degree of reaction, Head on machine, various efficiencies, Condition for maximum hydraulic efficiency.

Unit 2: Impulse and Reaction Turbines
Impulse principle, Construction of Pelton wheel, Velocity diagrams and its analysis, Number of buckets, Jets, Speed ratio, Jet ratio.
Reaction Turbines:
Constructional details of Francis, Kaplan and Propeller turbine, Deciaz turbine, and Draft tube types, Efficiencies, Cavitation.
Working of Mini and Micro Turbines.

Unit 3: Governing of Turbines

Methods of governing, Performance characteristics, Safety devices, Selection of turbines, Unit quantities, Specific speed, Principles of similarity and model testing.

Unit 4: Centrifugal Pump

Construction, Classification, Terminology related to pumps, Velocity triangle and their analysis, Cavitation, NPSH, Thoma's cavitation factor, Priming, Methods of priming, Specific speed, Performance characteristics, Actual thrust and its compensation, Troubleshooting.
Multistage Pumps: Pump H-Q characteristics and system H-Q Characteristics, Series and parallel operation of pumps, Systems in series and parallel, Principle of model testing and similarity.

Unit 5: Special Purpose Pumps

Chemical pumps, nuclear pumps, Sewage pumps, Submersible deep well pumps, Pump installation, Energy efficient pumps.
Failure of Pumping System: Pump failures, Remedies, Source failure, Causes and remedies, Trouble shooting.
Miscellaneous Pumps: Reciprocating pump, Gear pump, Vane pump, Lobe pump, etc., Application field (no mathematical treatment).

Texts:

1. P. N. Modi, S. M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Rajsons Publications Pvt. Ltd., 20^{th} edition.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Lakshmi Publications Pvt. Ltd., 9^{th} edition.

References:

1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications", McGraw Hill, 3^{rd} edition, 2014.
2. Seppo A. Korpela, *Principles of Turbomachinery*, John Wiley & Sons, 2^{nd} Edition, 2011.
3. Jagdish Lal, *Hydraulic Machines*, Metropolitan Book Company Pvt. Ltd., Revised Edition, 2010.
4. Earl Logan Jr., *Turbomachinery: Basic Theory and Applications*, CRC Press, 2^{nd} Edition, 2011.

Course Code:
Course Title: Sheet Metal Processing

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Recognize common manufacturing processes of Sheet Metal Fabrication
CO2	Understand the principles of design and fabricate of sheet metal products and recognize common material & properties used in the industry
CO3	Distinguish Shearing, Drawing and Bending processes.
CO4	Know types of dies and formability.
CO5	Select mechanical or hydraulic presses for the given process
C06	Determine the essential design parameters for Dies & Punches

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3
C06	3	2	2									1

Course Contents

Unit 1: Introduction

Importance of sheet metal engineering & advantages of sheet metal parts. Introduction to design to production processes in sheet metal industry. Various materials used in sheet metal industry for sheet metal, punches & dies. Desirable properties of materials used for sheet metal, punches & dies.

Unit 2: Basic Applications – Sheet Metal Blanking & Punching

Classification of sheet metal forming processes w. r. t. operations & stresses induced. Sheet metal cutting/ shearing & its mechanics, characteristics of sheared edges. Shearing processes like blanking & punching, punch & die arrangement, fine blanking. Introduction to various sheet metal operations like piercing, slotting, perforating, notching, semi-notching, nibbling, lancing, parting, cut-off, trimming, shaving, slitting & dinking.

Estimation of punch force & shear provision for reduction in punching force. Minimum diameter for punching. Estimation of clearance between punch & die, angular clearance for die. Determination of punch & die sizes considering the clearance. Strippers & its types, estimation of stripping force.

Unit 3: Sheet Metal Bending, Center of Pressure & Stock Strip Layout

Introduction to sheet metal bending & its types such as V-bending, Edge bending, bottoming & air bending. Minimum bending radius. Spring-back in bending and methods to compensate it. Introduction to other bending operations such as, flanging, hemming, seaming, curling & U-bending. Estimation of bending force in V bending & Edge bending. Bend allowance & its estimation for simple geometries.

Introduction & importance of Center of Pressure and its determination for simple geometries. Introduction to stock strip layout & its terminology. Formability & methods to test formability of sheet metals such as cupping test & forming limit diagram.

Unit 4: Sheet Metal Drawing

Introduction to sheet metal drawing & its mechanics. Difference between shallow and deep drawing, ironing, common defects in drawn parts. Estimation of corner radius & clearance on punch & die.

Determination of blank size, estimation of drawing force & blank holding force for round shaped cups. Percentage reduction in deep drawing & estimation of number of draws. Introduction to reverse redrawing.

Unit 5: Types of Dies, Presses & other Sheet Metal Operations

Dies: Introduction to compound die, progressive die, and combination die.

Presses: Classification of presses on the basis of power/ drive system and types of frames. Introduction to Mechanical and hydraulic press & its comparison.

Introduction to other Sheet Metal Operations: Coining, embossing, spinning, stretch forming. Introduction to high energy rate forming processes like explosive forming, electrohydraulic forming & electromagnetic forming. Introduction to Gurian process.

Case Studies: Few Case studies for manufacturing of sheet metal products, highlighting generic name of the product, material/s used for the product, sheet metal operations involved in the manufacturing of the product & sequence of operations.

Texts:

1. P.N. Rao, “Manufacturing Technology, Foundry, Forming and Welding”, Vol. I, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 4th edition, 2017
2. P.C. Sharma, “A Text Book of Production Engineering, S. Chand & Co. New Delhi, 11th edition, 2009

References:

1. M.P. Groover, Fundamentals of Modern Manufacturing, Materials processes & systems, John Wiley & sons, 2010.
2. S. Kalpakjian, Manufacturing Engineering & Technology, Prentice Hall, 6th Edition, 2009.
3. Donaldson et al., “Tool Design”, Tata McGraw-Hill Publications, New Delhi, 1998.
4. ASM Handbook, “Metal Forming”, Vol. XV, ASM Publication, Metals Park, Ohio,10th edition,1989.

Course Code:

Course Title: Engineering Economics

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents

Unit 1: Fundamentals of Economics and Engineering

Decision Making Meaning, scope, and significance of Engineering Economics, Basic economic concepts: scarcity, choice, utility, opportunity cost, Demand, supply, and market equilibrium, Market structures: perfect competition, monopoly, monopolistic competition, oligopoly, Microeconomics and Macroeconomics: concepts and applications, Economic systems and factors of production, Role of economics in engineering and industrial decision-making.

Unit 2: Time Value of Money and Economic Evaluation of Projects

Concept of time value of money, Simple and compound interest, Cash flow diagrams, Present worth, future worth, and annual worth methods, Capital recovery and sinking fund concepts, Nominal and effective interest rates, Loan amortization and depreciation methods, Inflation and its impact on engineering projects, Payback period, Net Present Value (NPV), Internal

Rate of Return (IRR), Benefit-Cost Ratio (BCR), Sensitivity and risk analysis.

Unit 3: Cost Analysis, Production Economics and Resource Management
Cost concepts: fixed, variable, direct, indirect, marginal and sunk costs, Cost-volume-profit analysis, Break-even analysis, Production function and productivity, Economies and diseconomies of scale, Cost-output relationships, Demand forecasting, Inventory management, Economic Order Quantity (EOQ), Capacity planning and resource allocation, Maintenance and replacement economics.

Unit 4: National Economy, GDP and Government Budget
National income concepts, Gross Domestic Product (GDP), Gross National Product (GNP), Net National Product (NNP), Methods of measuring GDP, Economic growth and development indicators, Inflation, unemployment, and business cycles, Indian Budget: structure and components, Revenue and capital receipts/expenditure, Fiscal policy and its impact on industry, Government initiatives for industrial and infrastructure development.

Unit 5: International Trade, Entrepreneurship and Sustainable Development
Fundamentals of international trade, Absolute and comparative advantage, Export and import procedures, Balance of trade and balance of payments, Foreign exchange and exchange rates, Globalization and its impact on Indian industries, WTO and international trade agreements, Entrepreneurship and startup economics, Sources of project finance, Sustainable development and green economics, Economic evaluation of renewable energy projects, Corporate Social Responsibility (CSR).

References:

1. Engineering Economy, William G. Sullivan, Elin M. Wicks & C. Patrick Koelling, Pearson.
2. Engineering Economy, Leland Blank & Anthony Tarquin, McGraw-Hill.
3. Principles of Economics, N. Gregory Mankiw, Cengage Learning.
4. Engineering Economics and Costing, S. P. Jain & K. L. Narang, Dhanpat Rai Publications.
5. Fundamentals of Engineering Economics, Chan S. Park, Pearson.
6. Indian Economy, Ramesh Singh, McGraw-Hill.
7. International Economics, Dominick Salvatore, Wiley.

Course Code:
Course Title: Automobile Engineering

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

CO1	Understand vehicle construction, classification and performance parameters
CO2	Analyze steering and suspension systems and identify faults
CO3	Explain transmission and power flow in automobiles
CO4	Evaluate braking system, tyres and vehicle safety aspects
CO5	Analyze electrical systems and diagnose faults
CO6	Apply knowledge of testing, maintenance and emission control

Mapping of course outcomes with program outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									1
CO2	3	3	2	1	1							1
CO3	3	2	2	1	1							1
CO4	3	2	2	1	1	2	1					1
CO5	3	3	1	2	2							2
CO6	3	3	2	2	2	2	3	1	1	1	1	2

Course Contents

Unit 1: Introduction
Vehicle specifications, Classifications, Chassis layout, Frame, Main components of automobile and articulated vehicles; Engine-cylinder arrangements, Power requirements, Tractive efforts and vehicle performance curves.

Unit 2: Steering and Suspension Systems
Steering system; Principle of steering, Centre point steering, Steering linkages, Steering geometry and wheel alignment, power steering. Suspension system: its need and types, Independent suspension, coil and leaf springs, Suspension systems for multi-axle vehicles, troubleshooting and remedies.

Unit 3: Transmission System
Clutch: its need and types, Gearboxes: Types of gear transmission, Shift mechanisms, over running clutch, Fluid coupling and torque converters, Transmission universal joint, Propeller shaft, Front and rear axles types, Stub axles, Differential and its types, Four-wheel drive.

Unit 4: Brakes, Wheels and Tyres
Brake: its need and types: Mechanical, hydraulic and pneumatic brakes, Disc and drum type: their relative merits, Brake adjustments and defects, Power brakes, Wheels and Tyres: their types; Tyre construction and specification; Tyre wear and causes; wheel balancing.

Unit 5: Electrical Systems, Vehicle Testing and Maintenance

Battery: construction, operation, maintenance, Charging system, cutout and regulators, Starter motor, Bendix drive, solenoid drive, Ignition systems and ignition timing, Vehicle testing: need, standards and types, Maintenance: troubleshooting, servicing, overhauling, engine tune-up, Tools and equipment, Emissions, pollution control systems and regulations

Texts:

1. Kripal Singh, “Automobile Engineering”, Vol. I and II, Standard Publishers.
2. G. B. S. Narang, “Automobile Engineering”, Dhanpat Rai and Sons.

References:

1. Joseph Heitner, “Automotive Mechanics”, East-West Press.
2. W. H. Crouse, “Automobile Mechanics”, Tata McGraw Hill Publishing Co.

Course Code:
Course Title: Applied Thermodynamics Lab

Teaching Scheme	Examination Scheme
Practical: 2 hrs/week Credits: 1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

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

CO1	Conduct performance and heat balance tests on IC engines, refrigeration systems, air compressors, and heat exchangers to evaluate key operational parameters.
CO2	Plot and analyze characteristic performance curves of thermal machinery and energy conversion systems.
CO3	Compare experimental/simulated results with theoretical thermodynamic cycles and conduct error analysis.
CO4	Model, simulate, and analyze gas/vapour power cycles and combustion systems using computational software tools (MATLAB/Simulink or open-source software).

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	2	1	-	1	-	1	1	-	1
CO2	2	2	1	2	2	-	-	-	1	1	-	1
CO3	2	2	2	2	2	-	-	-	1	1	-	1
CO4	2	3	2	2	3	-	1	-	1	1	-	2

List of Experiments (Any six):

1. Determine the Higher Calorific Value (HCV) and Lower Calorific Value (LCV) of solid/liquid fuel samples by Bomb Calorimeter.
2. Flue Gas analysis of the given sample of the Flue gases using gas analyser.
3. Preparation of Heat balance sheet of a Boiler and determination.
4. Determination of Boiler efficiency and Equivalent evaporation.
5. Simulation of vapour cycles; Rankine cycle, Otto cycle and Diesel cycle using appropriate software/development of code.
6. Simulation of steam Nozzle flow using appropriate software.
7. Determination of Diagram efficiency of the single stage impulse turbine.
8. Evaluate volumetric efficiency, isothermal efficiency, and pressure ratios of a air compressor setups.
9. Study of rotary and screw compressors using models.
10. Preparation of report based on the thermal power visit.

Course Code:
Course Title: Theory of Machines I Lab

Teaching Scheme	Examination Scheme
Practical: 2 hrs./week Credits:1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

Pre-requisite: Theory of Machines I (Theory)

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

CO1	Perform graphically kinematic analysis of any planar mechanism using ICR, RV & Klein's construction methods.
CO2	Sketch polar diagram for a Hooke's joint.
CO3	Demonstrate use of graphical differentiation method for kinematic analysis of slider crank mechanism or any other planar mechanism with a slider.
CO4	Understand the effect of Coriolis component of acceleration.
CO5	Measure jumping speed of follower
CO6	Perform balancing of rotating masses

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

List of Practical's/Experiments/Assignments:

1. Four sheets (half imperial size)
   Graphical solution of problems on velocity, acceleration in mechanisms by relative velocity method, instantaneous center of rotation method and Klein's construction. At least one problem containing Corioli's component of acceleration.

2. To draw cam profile for various types of follower motions.

3. Experiments:
   a) Experimental determination of velocity and acceleration of Hooke's joint.
   b) Determination of displacement of slider-crank mechanism with the help of model and to plot velocity and acceleration curves from it.
   c) Experiment on Corioli's component of acceleration.
   d) To study Static and Dynamic Balancing.
   e) To determine jumping speed of a follower using Cam-follower apparatus.

Course Code:
Course Title: Metrology Lab

Teaching Scheme	Examination Scheme
Practical: 2 hrs./week Credits:1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

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

CO1	Measure linear, angular circular features, dimensional and geometric features
CO2	Measure surface roughness of components
CO3	Calibration of metrological equipment

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	3	1							2
CO2			2	2		1		1				2
CO3			3	2		1						2

Course Contents

List of Practicals/Experiments/Assignments

[A] Any Four from experiment No. 1 to 5 and Any Four from experiment No. 6 to 10

1. Determination of linear and angular dimensions of given composite part using precision/non precision measuring instruments.
2. Error determination with linear / angular measuring instruments.
3. Calibration of measuring instrument. Example– Dial gauge, Micrometer, Vernier (any one)
4. Verification of dimensions & geometry of given components using Mechanical & Pneumatic comparator.
5. Machine tool alignment testing on any two machines.
6. Identification of surfaces using optical flat/interferometers and measure surface roughness using surface roughness tester.
7. Determination of geometry & dimensions of given composite object using profile projector and measurement of various angles of single point cutting tool using tool maker's microscope.
8. Measurement of thread parameters using floating carriage diameter measuring machine.
9. Measurement of spur gear parameters using Gear Tooth Vernier, Span, Gear Rolling Tester.
10. Determination of given geometry using coordinate measuring machine (CMM).

[B] Statistical Quality Control (SQC) (Any Two) Note - Use of computational tools are recommended

1. Analyze the fault in given batch of specimens by using seven quality control tools for engineering application.
2. Determination of process capability from given components and plot variable control chart/ attribute chart.
3. Case study on various tools in Total Quality Management (TQM).

[C] Industrial visit to Calibration lab / Quality control lab / Gear manufacturing unit / Automotive Industry / Engineering Industry.

Course Code:
Course Title: B. Tech Seminar

Teaching Scheme	Examination Scheme
Practical: 2 hrs./week Credits:1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

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

CO1	
CO2	
CO3	

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												

Objectives:

- Develop the ability to identify and study recent developments in Mechanical Engineering.
- Enhance technical literature survey and research skills.
- Improve technical report writing and documentation skills.
- Develop professional presentation and communication skills.
- Understand research ethics, plagiarism, and proper referencing techniques.

<u>Guidelines for Students</u>

Seminar Topic:

- Select a recent and emerging topic in Mechanical Engineering.
- Obtain approval of the seminar topic from the Faculty Guide.
- The topic should be based on recent research, technological developments, or industrial applications.

Literature Survey:

- Conduct an extensive literature survey using journals, conference papers, books, patents, and standards.
- Review and analyze recent research work critically.

- Identify research gaps and future scope.
- Use authentic sources such as IEEE, Springer, Elsevier, ASME, SAE, ASTM, etc.

Seminar Report:

- Report should preferably contain **30–50 pages**.
- Use **Letter Size (8.5" × 11")** paper.
- Use **Times New Roman**, **12 pt** font.
- Maintain **1.5 line spacing**.
- Use **SI Units** throughout the report.
- Follow either **British English** or **American English** consistently.

Report Format:

- Title Page
- Certificate
- Acknowledgement (Optional)
- Abstract (200–300 words) with Keywords
- Table of Contents
- List of Figures and Tables
- List of Symbols (if applicable)
- Introduction
- Literature Review
- Discussion and Analysis
- Conclusion
- References
- Appendix (Optional)

Formatting Guidelines:

- Left Margin: **3.75 cm**
- Top, Bottom and Right Margins: **2.5 cm**
- Chapter titles: **14 pt, Bold**
- Figures should have captions below the figure.
- Tables should have titles above the table.
- Number all figures, tables, and equations appropriately.

References:

- Follow **IEEE** or **Author–Date** referencing style.
- Include complete bibliographic details for every reference.
- Cite all borrowed figures, tables, and information properly.

Plagiarism and Ethics:

- Prepare the report in your own words.
- Properly acknowledge all sources.
- Maintain plagiarism within the permissible institute limit.
- Follow ethical practices in technical writing.

Seminar Presentation:

- Presentation Duration: **15–20 minutes**
- Viva-Voce: **10 minutes**
- Prepare a professional PowerPoint presentation.
- Demonstrate clear understanding of the selected topic..

Submission Requirements:

- Submit the final seminar report after incorporating all corrections suggested by the Guide.
- Obtain signatures of the **Faculty Guide** and **Head of the Department** before the seminar examination.
- Submit:
    - Soft copy (PDF)
    - Printed report (Soft Bound)
    - PowerPoint presentation
    - Plagiarism report (if applicable)

Evaluation Criteria:

- Topic Selection and Literature Survey
- Technical Content and Analysis
- Report Quality and Documentation
- Presentation Skills
- Viva-Voce and Technical Discussion

Course Code: ~~25AF1000BS301~~

Course Title: Field /Industrial Training – I (To be started)

Teaching Scheme	Examination Scheme
Credits: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: --

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

The students should identify a relevant industry in consultation with the allocated guide in the college and undertake the one-month industrial training with an objective to understand the industrial processes, tools, equipment, safety rules etc.

Semester VI

Course Code:
Course Title: Heat Transfer

Teaching Scheme	Examination Sch
Lecture: 2 hrs/week Tutorial: 1 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the laws of heat transfer and deduce the general heat conduction equation and to explain it for 1-D steady state heat transfer in regular shape bodies
CO2	Describe the critical radius of insulation, overall heat transfer coefficient, thermal conductivity and lumped heat transfer
CO3	Interpret the extended surfaces
CO4	Illustrate the boundary layer concept, dimensional analysis, forced and free convection under different conditions
CO5	Describe the Boiling heat transfer, Evaluate the heat exchanger and examine the LMTD and NTU methods applied to engineering problems
CO6	Explain the thermal radiation black body, emissivity and reflectivity and evaluation of view factor and radiation shields

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	1	-	-	-	-	-	-	-
CO2	3	3	2	1	1	-	1	-	-	-	-	-
CO3	3	2	2	1	1	-	-	-	-	-	-	-
CO4	3	3	2	2	2	-	1	-	-	-	-	-
CO5	3	3	3	2	2	1	1	-	-	-	-	1
CO6	3	2	2	1	1	1	2	-	-	-	-	1

Course Contents:

Unit 1: Introduction
Heat transfer mechanism, conduction heat transfer, Thermal conductivity, Convection heat transfer, Radiation heat transfer, laws of heat transfer Steady State Conduction: General heat conduction equation, Boundary and initial Conditions, one dimensional steady state conduction: the slab, the cylinder, the sphere, composite systems.

Unit 2: Overall Heat Transfer and Extended Surfaces
Thermal contact resistance, Critical radius of insulation, Electrical analogy, and Overall heat transfer coefficient, Heat sources systems, Variable thermal conductivity, extended surfaces. Unsteady State Con duction: Lumped system analysis, Biot and Fourier number, Heisler chart **(Numerical examples).**

Unit 3: Principles of Convection

Continuity, Momentum and Energy equations, Hydro dynamic and Thermal boundary layer for aflat plate and pipe flow. Dimensionless groups force convection, relation between fluid friction and heat transfer, turbulent boundary layer heat transfer. Forced

Convection:

Empirical relations for pipe and tube flow, flow a cross cylinders, spheres, tube banks. Free Convection: Free convection from a vertical, inclined and horizontal surface, cylinder and sphere. (Numerical examples).

Unit 4: Heat Exchangers

Heat Exchangers: Classification of heat exchangers, temperature distribution in parallel counter flow arrangement, the overall heat transfer coefficient, Analysis of heat exchangers, the log mean temperature difference (LMTD) method, the effectiveness – NTU method, selection of heat exchangers, Introduction to TEMA standard. (Numerical examples).

Unit 5: Radiation Heat Transfer

Introduction, thermal radiation, Black body radiation, radiation laws, Radiation properties, Atmospheric and Solar radiation, the view factor Radiation heat transfer from black surfaces, gray surfaces, diffuses surfaces, Radiation shield sand the radiation effect. (Numerical examples).

Texts:

1. F. P. Incoropera, D. P.Dewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley, 5th edition,1990.
2. S. P. Sukhatme, “A Text book On Heat Transfer”, Tata McGraw-Hill Publications, 3rd edition.

References:

1. Y. A. Cengel, “Heat Transfer – A Practical Approach”, Tata McGraw Hill Publications,3rd edition, 2006.
2. J. P. Holman, “Heat Transfer”, Tata McGraw Hill Publications,10th edition,2010.
3. P.S. Ghoshdastidar, “Heat Transfer”, Oxford University Press, 2nd edition 2012.

Course Code:
Course Title: Theory of Machines II

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Credits: 03	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mechanics, TOM - I

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

CO1	Identify and select type of belt drive for a particular application.
CO2	Evaluate gear tooth geometry and select appropriate gears, gear trains.
CO3	Characterize flywheels as per application requirement.
CO4	Understand gyroscopic effects in ships, aeroplanes, and road vehicles.
CO5	Understand free and forced vibrations of single degree freedom systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Belt Drives
Flat belts: Effect of slip, Creep, crowing of pulley, Length of belt, Centrifugal tension, Initial tension in belts, ratio of belt tensions, power transmitted. V-Belts: Advantages of V-Belts over Flat Belt, ratio of belt tensions, torque transmitted.

Unit 2: Toothed Gears
Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profiles, Path of contact, Arc of contact, Contact ratio, Interference, Undercutting, Backlash. Introduction to Internal gears. Helical gear terminology, Normal and transverse module, Virtual number of teeth.

Unit 3: Worm & Bevel Gear & Gear Trains
Introduction & terminology of Worm gears & Bevel gear, concept of virtual number of teeth in bevel gear, Efficiency of worm gear.

Types of gear trains, Simple, Compound & Reverted Gear Trains, their Velocity ratios, Simple Epicyclic Gear Train & its Velocity Ratios.

Unit 4: Flywheel and Gyroscope
Flywheel: Turning moment diagram, Energy stored in the flywheel, Fluctuation of energy and speed, Determination of mass of flywheel for four stroke single cylinder IC Engine & simple

Punching Press.

Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on Aeroplane, Naval ships and four wheelers.

Unit 5: Vibrations

Mechanical Vibration**:** Basic concepts and definitions of Vibration, Single degree of freedom system, Undamped free vibrations, Natural frequency of Longitudinal & transverse vibrations of shaft with point loads (neglecting inertia), Introduction to damped free vibrations & equation of motion, Types of damping. Critical or whirling Speed of shaft in undamped system. Introduction to forced vibrations. Torsional Vibrations**:** Natural frequency & modes of single and two rotor system.

Texts:

1. S. S. Rattan, "Theory of Machines," Tata McGraw Hill Publications, New Delhi.
2. Thomas Beven, "Theory of machines," CBS Publishers, Delhi, 1984.
3. Kelly, Graham S., "Mechanical Vibrations," Schaum's Outline Series, McGraw Hill, New York, 1996.
4. Rao, J.S., "Introductory Course on Theory and Practice of Mechanical Vibration", New age International (P) Ltd, New Delhi, 2nd edition, 1999.

References:

1. Rao Singiresu, "Mechanical Vibrations", Pearson Education, New Delhi, 4th edition 2004.
2. J. E. Shigley, J. J. Vicker, "Theory of Machines and Mechanisms", Tata McGraw Hill International.

Course Code:
Course Title: Machine Design - I

Teaching Scheme:	Examination Scheme:
Lectures: 2 hrs/week Tutorial: 1 hr/week Credits: 3	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Introduction to Mechanical Design & Design Against Static Loads
Mechanical Engineering Design: Definition, Meaning, Importance, Phases of Design: Traditional vs. Industrial Design Process, Design Considerations: Aesthetic, Ergonomic, Standardization, Preferred Numbers, Use of Design Data Book and ISO 9000, Selection of Materials, Stresses and Strain: Axial, Bending, and Torsion, Introduction to Concurrent Engineering and Integrated Design
Static Loading: Design of Cotter Joint, Knuckle Joint and Members subjected to Eccentric loading.

Unit 2: Design Against Fluctuating Loads & Theories of Failure
Types of Loading: Static vs Fluctuating, Stress Concentration: Causes, Factors & Reduction, Endurance Limit, Fatigue Failure, Notch Sensitivity, Design for Finite and Infinite Life, Cumulative Damage Soderberg and Goodman Diagrams, (Numerical treatment included)
Theories of Failure: Maximum Normal Stress Theory, Maximum Shear Stress Theory, Maximum Distortion Energy Theory, Comparison of Theories, Combined Loading Applications

Unit 3: Design of Shafts, Keys and Couplings
Types of Shafts: Transmission Shafts, Spindles, Axles, Design for Strength and Rigidity (Torsional & Bending), ASME Code for Shaft Design, Types of Keys: Flat, Square; Design and Fitment, Splined Shafts Overview, Design of Rigid Couplings: Muff, Flange, Design of Flexible Couplings: Bush pin, etc.

Unit 4: Design of Power Screws and Welded Joints
Power Screws: Types of Threads, Terminology, Torque for Lifting/Lowering, Self-Locking, Efficiency, Overall and Thread Efficiency, Design of Screw, Nut, Compound, Differential Screws, Introduction to Recirculating Ball Screw, Welded Joints: Types (Butt, Fillet), Strength Calculations, Welded Joints under Eccentric Load and Bending.

Unit 5: Design of Mechanical Springs
Springs: Types and Applications, Terminology and Material Selection, Helical Compression Springs: Stress-Deflection Equation, Wahl's Factor, End Styles, Shot Peening, Design of Tension and Compression Springs, Torsion Springs, Multi-leaf Springs, Nipping Concept,

Texts

1. V. B. Bhandari – *Design of Machine Elements*, Tata McGraw Hill Publication

References

1. Shigley J. E. & Mischke C. R. – Mechanical Engineering Design, Tata McGraw Hill
2. M. F. Spotts – *Design of Machine Elements*, Pearson Education
3. Robert L. Norton – *Machine Design: An Integrated Approach*, Pearson.

Course Code:
Course Title: Mechatronics

Teaching Scheme:	**Examination Scheme:**
Lectures: 2 hrs/week Credits: 3	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Introduction
Introduction to Mechatronic systems, elements, advantages; practical examples of Mechatronic systems.
Sensors and Transducers: Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2: Signal Conditioning and Data Representation
Types of electronic signals, Need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays.
Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3: Drives
Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics: Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electropneumatic valves, Electropneumatic circuits using single and double solenoid methods. Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4: Microprocessor and Microcontroller

8085 Microprocessor: architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications.

8081 Microcontroller: architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller: Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5: Control Systems

Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using Spring, Dashpot and Mass equivalence.

Stability of Systems: On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

Texts:

1. HMT Limited, “Mechatronics”, Tata McGraw Hill Publications, 1998.
2. W. Bolton, “Mechatronics; Electronic Control System in Mechanical Engineering”, Pearson Education Asia, 1999.
3. Raven, “Automatic Control Engineering”, Tata McGraw Hill Publications, New York, 1986.

References:

1. R. K. Rajput, “A textbook of Mechatronics”, S. Chand and Co., 2007.
2. Michael B. Histand, David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill International Editions, 2000.
3. D. A. Bradley, D. Dawson, N. C. Buru, A. J. Loader, “Mechatronics”, Chapman and Hall, 1993.

Course Code:
Course Title: Finite Element Method

Teaching Scheme:	**Examination Scheme:**
Lectures: 2 hrs/week Credits: 3	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Introduction
Finite element analysis and its need, Advantages and limitations of finite element analysis (FEA), FEA procedure.
Relevant Matrix Algebra: Addition, subtraction and multiplication of matrices, Differentiation and integration of matrices, Inverse of a matrix, Eigen values and eigen vectors, Positive definite matrix, Gauss elimination.

Unit 2: Elements of Elasticity
Stress at a point, Stress equation of equilibrium, 2-D state of stress, Strains and displacements, Stress-strain relationship for 2-D state of stress, Plane stress and plane strain approach.

Unit 3: One-Dimensional Problems
Introduction, FE modeling, Bar element, Shape functions, Potential energy approach, Global stiffness matrix, Boundary conditions and their treatments, Examples.

Unit 4: Trusses and Frames
Introduction, Plane trusses, Element stiffness matrix, Stress calculations, Plane frames, examples.

Unit 5: Two-dimensional Problems
Introduction and scope of 2-D FEA, FE modeling of 2-D problem, Constant strain triangle, other finite elements (no mathematical treatment included), Boundary conditions.

Texts:

1. T. R. Chandrupatla, A.D. Belegundu, “Introduction to Finite Elements in Engineering”, Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.
2. P. Seshu, “A Textbook of Finite Element Analysis”, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, “Concepts and Applications of Finite Element Analysis”, John Wiley &Sons, Inc.

References:

1. K. J. Bathe, “Finite Element Procedures”, Prentice Hall of India Pvt. Ltd., 2006.

Course Code:
Course Title: Product Life Cycle Management

Teaching Scheme:	**Examination Scheme:**
Lectures: 2 hrs/week Credits: 3	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

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

CO1	Understand PLM concepts, strategies and lifecycle phases
CO2	Analyze Product Data Management systems and implementation challenges
CO3	Apply product design and development methodologies
CO4	Evaluate new product development strategies and market considerations
CO5	Analyze technology forecasting methods for future planning
CO6	Apply PLM tools, workflow and data management in engineering systems

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1		1					1	2	1
CO2	2	3	1	1	2				1	1	2	1
CO3	3	3	3	2	2				1	1	2	1
CO4	2	3	2	2	1	1	1		1	1	3	1
CO5	2	3	1	2	1						2	2
CO6	3	2	2	1	3				1	1	2	2

Course Contents

Unit 1: Introduction and Strategies to PLM

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2: Product Data Management

Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3: Product Design and Development

Engineering design and product design process, Organization and decomposition in product design, Concurrent engineering, Design for X (DFX), Modeling and simulation, Structuring new product development, Market analysis and financial control, Product launch and tracking, Product redesign concepts

Unit 4: Technology Forecasting

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

Unit 5: PLM Software and Tools

Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications

References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. Antti Saaksvuori, Anselmi Immonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes".

Course Code:
Course Title: Robotics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs /week Tutorial: 1 hrs /week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	List the various components of a typical Robot, grippers, sensors, drive system and describe their functions
CO2	Calculate the word to joint and joint to word coordinates using forward and reverse transformations
CO3	Calculate the gripper forces, drive sizes, etc.
CO4	Develop simple robot program for tasks such as pick and place, arc welding, etc. using some robotic language such as VAL-II, AL, AML, RAIL, RPL, VAL
CO5	Evaluate the application of robots in applications such as Material Handling, process operations and Assembly and inspection
CO6	Discuss the implementation issues and social aspects of robotics

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents

Unit 1: Introduction
Various basic components of a Robotic system, various configurations, work envelopes, Manipulators, sensors, controllers, etc.

Unit 2: Mechanical System in Robotics
Motion conversion, Kinematic chains, position analysis, forward and backward transformations, natural and joints pace coordinates.

Unit 3: Drives for Robot
Electrical drives, Stepper motor, DC motors, AC motors, hydraulic and pneumatic drives, hybrid drives, drive selection for robotics joints.

Unit 4: Sensors in Robotics
Position sensor, velocity sensor, proximity sensors, touch sensors, force sensors, etc.

Unit 5: Robot Programming and its Application
Path planning, lead through (manual and powered) programming, teach pendant mode, programming languages, AL, AML, RAIL, RPL, VAL, VAL – II.

Artificial Intelligence for Robots: Knowledge Representation, Problem representation and problem solving, search techniques in problem solving

Applications: Application of robot in: Material handling, assembly and inspection, process operations, etc.

Texts

1. M. P. Grover, "Industrial Robotics: Technology, Programming and Applications", Tata McGraw Hill Publication.

References

1. Saeed B. Niku, "Introduction to Robotics, Analysis, Systems, Applications", Pearson Education.
2. Richard D. Klafter, "Robotic Engineering: An Integrated Approach", Prentice Hall of India.

Course Code:
Course Title: Internal Combustion Engines

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

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

CO1	Understand various types of I.C. Engines and Cycles of operation.
CO2	Analyze the effect of various operating variables on engine performance
CO3	Identify fuel metering and fuel supply systems for different types of engines
CO4	Understand normal and abnormal combustion phenomena in SI and CI engines
CO5	Evaluate performance Analysis of IC Engine and Justify the suitability of IC Engine for different application
CO6	Understand the conventional and non-conventional fuels for IC engines and effects of emission formation of IC engines, its effects and the legislation standards

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1								
CO2	3	3	2	2	1							
CO3	3	2	2	1	2							
CO4	3	3	2	2	1	1	1					
CO5	3	3	3	2	2	1	1				1	1
CO6	3	2	2	1	2	2	3				1	2

Course Contents

Unit 1: Fundamentals of IC Engines
Applications, nomenclature, engine components, Engine classification, two and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.
Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles and deviation of actual cycles from ideal cycles.

Unit 2: Combustion
Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of C.I. Engine fuels.
Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; types of SI and CI Engine combustion chambers.

Unit 3: Various Engine Systems and Engine Testing and Performance

Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems. Engine Testing and Performance of SI and CI Engines Parameters, Type of tests and characteristic curves.
Super charging in IC Engine: Effect of attitude on power output, types of supercharging. **Engine Emissions and control**: Pollutants from SI and CI engines and their control, emission regulations such as Bharat and Euro.

Unit 4: Alternate Fuels

Need for alternative fuels, applications, various alternate fuels etc Gaseous Fuels, Alcohols, Biodiesels, vegetable oil extraction, Trans-esterification process, properties of alternative fuels and fuel blends.
Fuel Cell Technology: Operating principles, Types, construction, working, application, advantages and limitations.

Unit 5: Layout of Electric vehicle and Hybrid vehicles

Advantages and drawbacks of electric and hybrid vehicles, System components, Electronic control system – Different configurations of Hybrid vehicles, Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

References:

1. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Publications, New Delhi, 3rd edition.
2. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988.
3. "Alternative Fuels", Dr. S. S. Thipse, Jaico publications.
4. "IC Engines", Dr. S. S. Thipse, Jaico publications.
5. "Engine Emissions, pollutant formation", G. S. Springer and D.J. Patterson, Plenum Press.
6. ARAI vehicle emission test manual.
7. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, "The Biodiesel Handbook", AOCS Press Champaign, Illinois 2005.
8. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997, ISBN 0-76-80-0052-1.
9. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.

Course Code:
Course Title: Computational Fluid Dynamics

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Credits: 3	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Fluid Mechanics and Heat Transfer

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

CO1	Understand the principles of Computational Fluid Dynamics, Discretization and PDE
CO2	Solution and implementation of the CFD using PDE and discretization
CO3	Understanding the Finite Volume approach
CO4	Solution of the Linear Algebraic Equations using CFD
CO5	Application to solve NS Equation, convection diffusion

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1		1							
CO2	3	3	2	2	2							
CO3	3	3	2	2	1							
CO4	3	3	3	3	3							
CO5	3	3	3	3	3							

Course Contents

Unit 1: Introduction to Computational Fluid Dynamics and Principles of Conservation
Computational Fluid Dynamics: What, When, and Why? CFD Applications, Numerical vs Analytical vs Experimental, Modeling vs Experimentation, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation.
Classification of Partial Differential Equations and Physical Behaviour: Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations.

Unit 2: Approximate Solutions of Differential Equations
Error Minimization Principles, Functional involving higher order derivatives, Approximate solution of differential equations through variational formulation, Boundary

conditions in the variational form: Primary and secondary variables. Essential and natural boundary conditions, Approximate solutions of differential equations, Properties of variational form, weighted residual approach: trial function and weighting function, Requirement of trial function and weighting function, least square method, Point Collocation method, Galerkin's method, Rayleigh-Ritz method.

Fundamentals of Discretization: Discretization principles: Pre-processing. Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM). Illustrative examples: 1-D steady state heat conduction without and with constant source term.

Unit 3: Finite Volume Method

Some Conceptual Basics and Illustrations through I-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a I-D steady state diffusion type problem, Composite material with position dependent thermal conductivity. Four basic rules for FV Discretization of 1-D steady state diffusion type problem. Source term linearization, Implementation of boundary conditions.

Discretization of Unsteady State Problems: 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme.

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consequences of time-discretization in finite discretization, Consistency, Stability, Convergence, LAX Equivalence theorem, Grid independent and time independent study, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Stability analysis of 2nd order hyperbolic equations: CTCS scheme.

Unit 4: Solution of Systems of Linear Algebraic Equations

Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search method, Elimination method: Forward elimination and backward substitution, Assessment of number of computations, L-U decomposition technique, Tridiagonal matrix algorithm (TDMA): Thomas algorithm, Illustrative examples, Norm of a vector, Norm of a matrix, Some important properties of matrix norm, Error analysis of elimination methods, Iteration methods: Jacobi's method and Gauss Siedel method, Generalized analysis of the iterative methods, Sufficient condition for convergence, Rate of convergence, Scarborough criteria of sufficient condition for convergence in Gauss Siedel Method, Illustrative examples of Jacobi's method and Gauss-Siedel method, Relaxation methods, Preferential characteristics of iterative methods, Multigrid method, Line by line TDMA, ADI (Alternating direction implicit) method, Gradient search methods: Steepest descent method and Conjugate gradient method.

Unit 5: Discretization of Convection-Diffusion Equations

A Finite Volume Approach: Finite volume discretization of convection-diffusion problem: Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem, The concept of false diffusion, QUICK scheme.

Unstructured Grid Formulation: Discretization of the Momentum Equation using unstructured grid.

What is there in implementing a CFD code: The basic structure of a CFD code: Pre-processor, Solver and Post-processor, User-defined-subroutines, Solution to some basic problems in heat transfer and fluid flow.

Introduction to Turbulence Modeling: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The K-Ɛ model, Advantages and disadvantages of K-Ɛ model, More two-equation models: RNG K-Ɛ model and K-ω model, Reynolds stress Model (RSM), Large eddy Simulation (LES), Direct numerical simulation (DNS).

Texts:

1. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
3. H. K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.

References:

1. J. H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer.
2. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
3. John D. Anderson Jr. Computational Fluid Dynamics, McGraw Hill Book Company.
4. J. Blazek, Computational Fluid Dynamics: Principles and Applications, Elsevier.
5. http://www.nptel.iitm.ac

Course Code:
Course Title: Theory of Machines II Lab

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week Credit: 1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

Pre-requisite: Theory of Machines II (Theory)

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

CO1	Explain various types of gear drives, gear boxes, gear trains, belt and rope drives.
CO2	Interpreting physical principles and phenomenon of gyroscopic couple.
CO3	Measure vibration parameters in single degree of freedom systems.
CO4	Measure critical speed of a single rotor system.
CO5	Understand behavior of epicyclic gear train.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

List of Practical's/Experiments/Assignments (Any Ten)

Term work should consist of chosen experiments from the below given list.

1. Study of various types of gear boxes such as Industrial gear box, Synchromesh gear box, Differential gear box, etc.
2. To draw conjugate profile for any general shape of gear tooth.
3. To generate gear tooth profile and to study the effects under cutting and rack shift using models.
4. Verification of principle of gyroscope and gyroscopic couple using motorized gyroscope.
5. To verify the relation $T = 2\pi\sqrt{(L/g)}$ for simple pendulum.
6. To study the longitudinal vibrations of helical spring and to determine the frequency or period of vibration (oscillation) theoretically and experimentally.
7. To study the un-damped free vibration of equivalent spring mass system.
8. To study the forced vibrations of equivalent spring mass system.
9. To determine the natural frequency of damped vibration of a single degree of freedom system and to find its damping coefficient.
10. To verify natural frequency of torsional vibration (un-damped) of two rotor system and position of node.
11. To determine critical speed of a single rotor system.
12. To determine transverse natural frequency of a beam experimentally using frequency measurement setup.

13. To determine the frequency response curve under different damping conditions for the single degree of freedom system.
14. Study of epicyclic gear train and its dynamic behavior.
15. Multibody dynamics and motion analysis by using (Adams) software.

Course Code:
Course Title: Machine Design Practice-I

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week Credit: 1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

Pre-requisite: MD I (Theory)

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

List of Practicals/Experiments/Assignments

1. The term work shall consist of two design projects based on the syllabus of Machine Design - I. Each design project shall consist of two imperial size sheets - one involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it working drawing
2. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file.
3. Two assignments based on topics of syllabus of Machine Design – I.

Course Code:

Course Title: Heat Transfer Lab

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week Credit: 1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

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

CO1	Understand the various heat transfer mode of heat transfer and its application and verify
CO2	Learn the experimental methodology
CO3	Describe the concept the terms like least count, calibration of the instruments

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												

List of Practical's /Experiments

Any eight experiments from the list:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of conductivity of a composite slab.
4. Temperature distribution on a fin surface.
5. Determination of film heat transfer coefficient for natural convection.
6. Determination of film heat transfer coefficient for forced convection.
7. Determination of heat transfer coefficient for cylinder in cross flow in forced convection.
8. Performance of Double pipe Heat Exchanger / Shell and Tube Heat Exchanger.
9. Determination of emissivity of a metal surface.
10. Determination of Stefan Boltzman's constant.
11. Determination of critical heat flux.
12. Determine the experimental and theoretical heat transfer coefficient for drop wise and film wise condensation.

Course Code:
Course Title: Mechatronics Lab

Teaching Scheme	Examination Scheme
Practical: 2 hrs/week Credits: 1	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

List of Practical's /Experiments

List of Practicals/Experiments (Any Five)

1. Study and demonstration of various types of sensors.
2. Speed control of various types of Electrical Motors.
3. Minimum two circuits on Pneumatics to be developed on Pneumatic trainer kit.
4. Minimum two circuits on Electro-Pneumatics to be developed on Electro-pneumatic trainer kit.
5. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit.
6. Programming of Microprocessor and Microcontroller
7. Programming on PLC.
8. Demonstration of Process control such as temperature, level, flow, etc. control using PID controller.

Course Code:
Course Title: Technical Project Related to Community Services

Teaching Scheme	Examination Scheme
Practical: 2 hrs/ week Credit: 1	Continuous Assessment: 60 Marks Practical/ Oral: 40 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes:

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Course Objectives: The main objective of TPCS is to let the students apply the knowledge of theoretical concepts which they have learnt as a part of the curriculum of the undergraduate courses to real time problems or situations related to community and societal issues.

Course Guidelines:

- Students can choose projects based on societal problems or user defined problem which must emulate real-life problems and useful for the community.
- It is desirable that students should work on the project in groups of 2 or 3 but not more than three.
- After making the group, students must decide the title of the project in consultation with the guide and finalize the topic. Topics may be found by looking through recent issues of peer reviewed Journals/Technical Magazines on the topics of potential interest
- Each student is requested to develop a working model/ process/ software package /system on the chosen work and demonstrate before the evaluation committee (Guide & Internal Examiner)

- Finally, students must submit the final report of the project and the format for the same will be given by the department.
- The students will report to the respective guide/supervisor every fortnight to discuss their progress.
- The final evaluation of the project will be done based on the demonstration and presentation. It is mandatory for the student to:

  i. appear for final presentation (PPT with informative slides) and viva-voce to qualify for course evaluation
  ii. submit a well-documented TPCS report as per the format.

Course Evaluation:

Evaluation weightage for the TPCS is as follows:
- TPCS Supervisor Assessment 30%
- Working model / process / software package / system developed (20%)
- TPCS report (20%)
- Final presentation (with PPT) and viva-voce (30%)
- The student must register for the TPCS project as supplementary examination in the following cases:

  i. he/she is absent for oral presentation and viva-voce
  ii. he/she fails to submit the report in prescribed format
  iii. he/she fails to fulfil the requirements of Mini project evaluation as per specified guidelines.

Course Code:

Course Title: Field /Industrial Training – I (To be completed)

Teaching Scheme	Examination Scheme
Credits: --	Continuous Assessment: -- End Semester Exam: --

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes:

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

The students should complete their training by the end of this semester. The students are expected to understand the industrial processes, tools, equipment, & safety rules. Besides, it is expected to improve the technical skills, communication, teamwork, problem-solving ability, and professional behaviour through hands-on experience and interaction with industry experts.