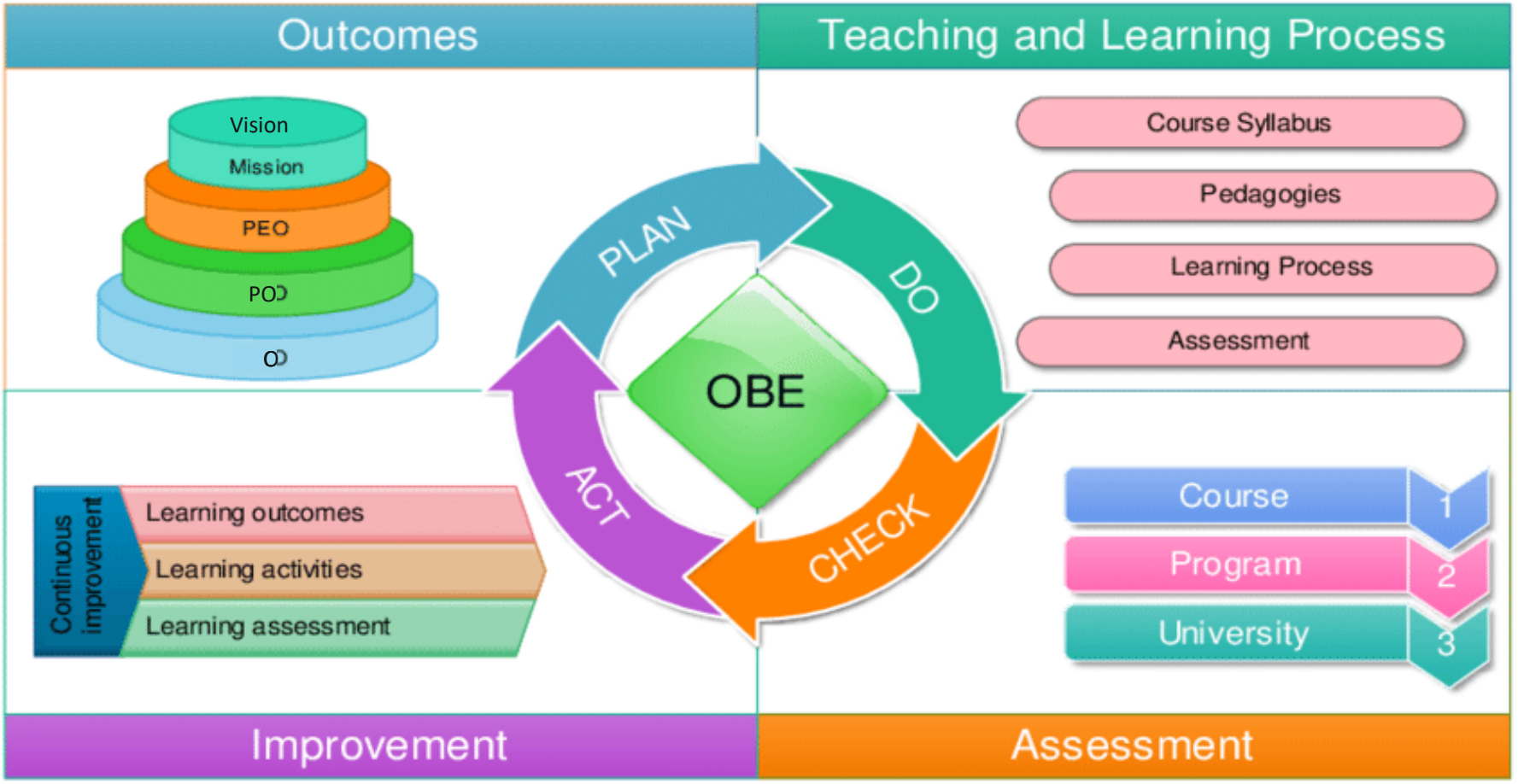
SANSKRITHI SCHOOL OF ENGINEERING
PUTTAPARTHI

Outcome Based Education (OBE) Manual

Academic Year 2021-22

Team OBE
SSE, Puttaparthi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Abbreviations:

OBE	Outcome Based Education	**BTL**	Bloom's Taxonomy Level
LOT	Lower Order of Thinking	**HOT**	Higher Order of Thinking
PEO	Program Educational Objectives	**PO**	Program Outcome
CO	Course Outcome	**PSO**	Program Specific Outcome
UE	University Theory Exam	**POE**	Practical Oral Exam
CE	Course Exit Survey	**HoD**	Head of Department
PC	Program Coordinator	**DAB**	Department Advisory Board
PAC	Program Assessment Committee	**AY**	Academic Year

Preamble

Outcome Based Education (OBE) is an educational model that forms the base of a quality education system. There is no single specified style of teaching or assessment in OBE. All educational activities carried out in OBE should help the students to achieve the set goals. The faculty may adapt the role of instructor, trainer, facilitator, and/or mentor, based on the outcomes targeted.

OBE enhances the traditional methods and focuses on what the Institute provides to students. It shows the success by making or demonstrating outcomes using statements "able to do" in favor of students. OBE provides clear standards for observable and measurable outcomes.

Benefits of OBE

- **Clarity:** The focus on outcome creates a clear expectation of what needs to be accomplished by the end of the course.
- **Flexibility:** With a clear sense of what needs to be accomplished, instructors will be able to structure their lessons around the students' needs.
- **Comparison:** OBE can be compared across the individual, class, batch, program and institute levels.
- **Involvement:** Students are expected to do their own learning. Increased student involvement allows them to feel responsible for their own learning, and they should learn more through this individual learning.

India, OBE and Accreditation

From 13th June 2014, India has become the permanent signatory member of the Washington Accord. Implementation of OBE in higher technical education also started in India. The National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA) are the autonomous bodies for promoting global quality standards for technical education in India. NBA has started accrediting only the programs running with OBE from 2013.

The National Board of Accreditation mandates establishing a culture of outcome based education in institutions that offer Engineering, Pharmacy, Management program. Reports of outcome analysis help to find gaps and carryout continuous improvements in the education system of an Institute, which is very essential.

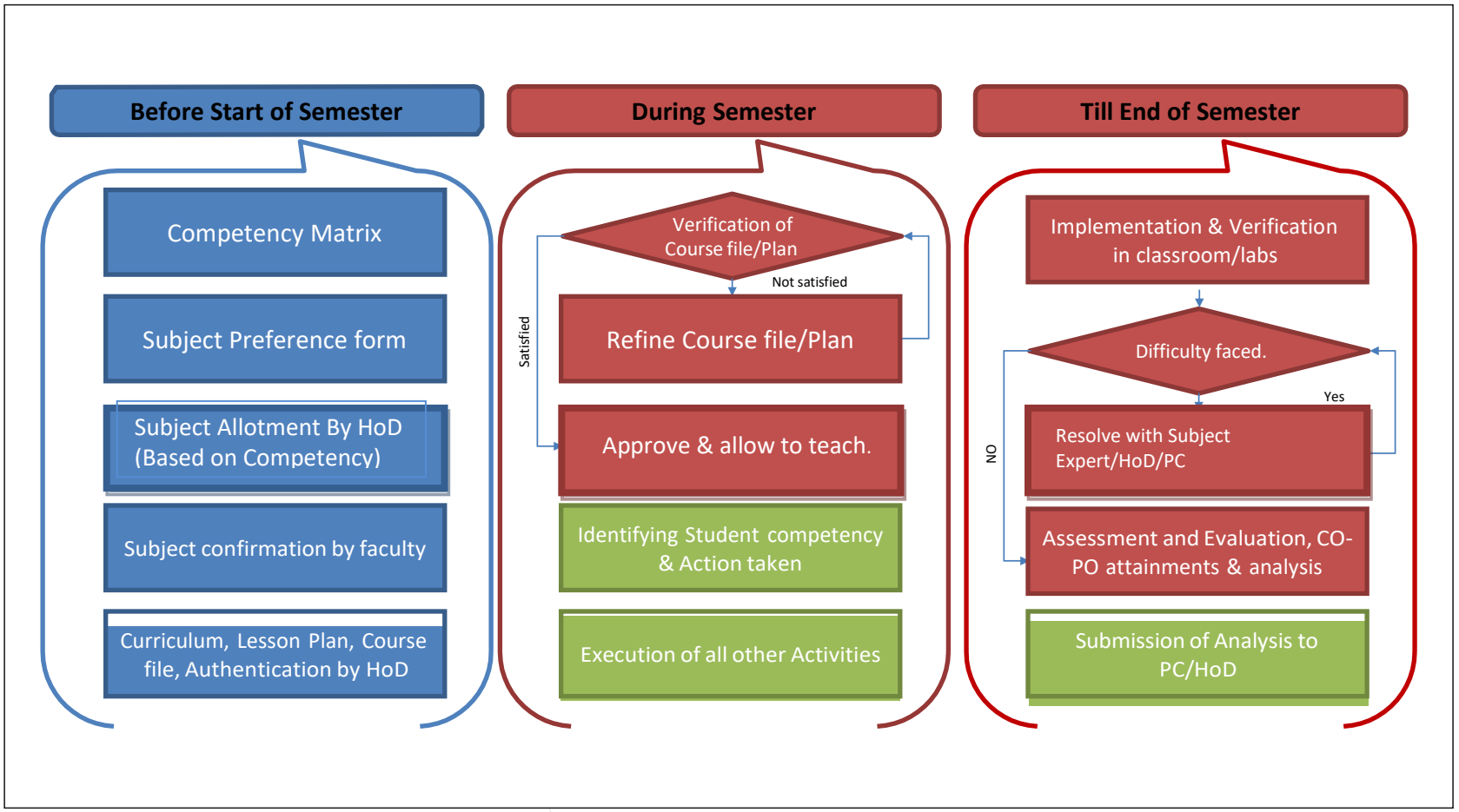
Vision, Mission and Quality Policy of Institute

Vision of Institute: To develop dynamic and socially responsible engineers possessing wisdom, positive attitude, and an impeccable character.

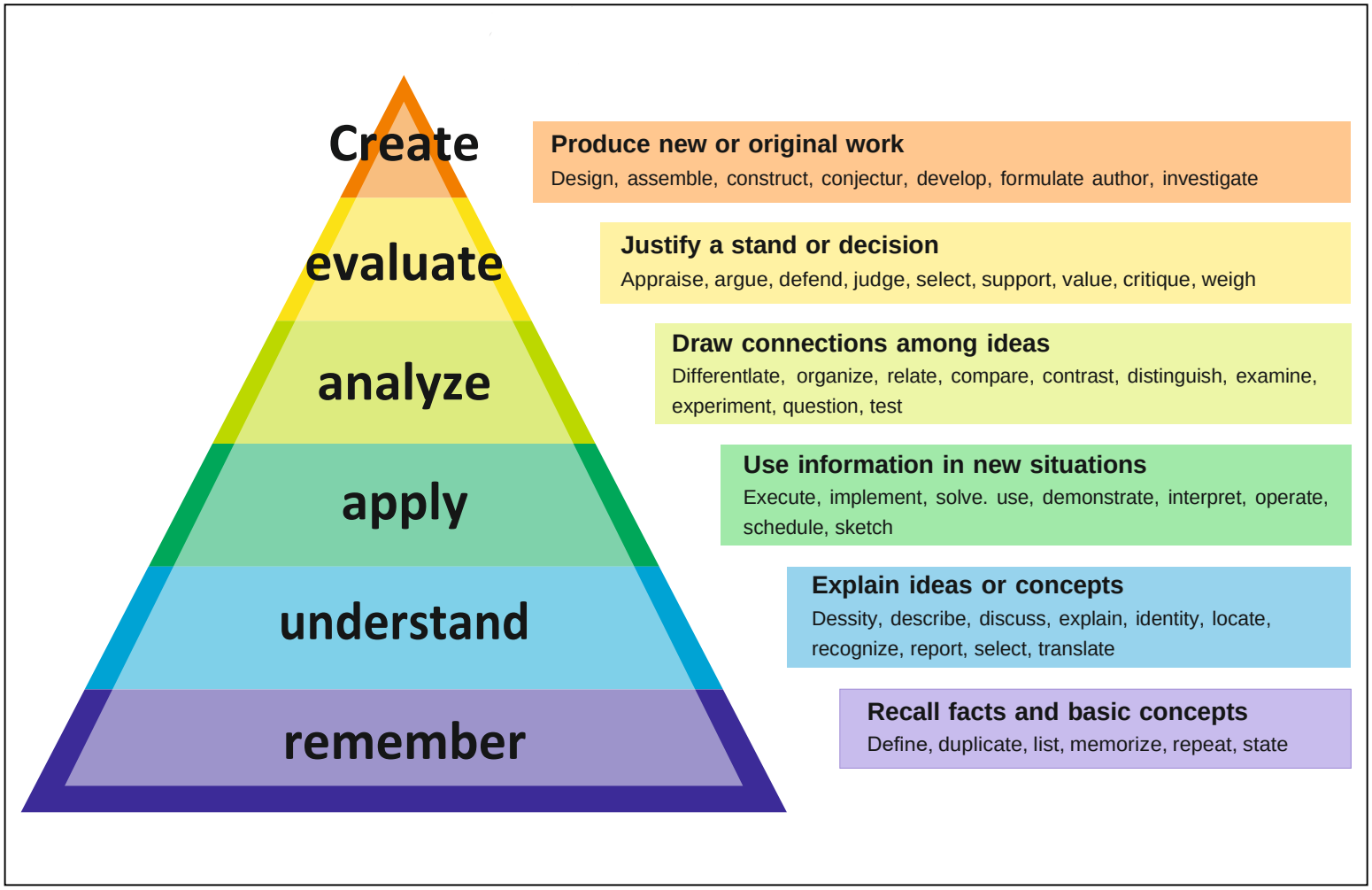
Mission of Institute:	**Quality Policy of Institute:**
1. The college is devoted to serving society and the nation by providing quality education, and skill development programs thereby enabling the students to become skilled engineers with the right kind of knowledge. 2. Committed towards setting new benchmarks of excellence in engineering education with emphasis on research & development, innovation and services to society, industry, and the world.	We at Sanskrit School of Engineering endeavor to uphold excellence in all spheres by adopting best practices in effort and effect.

Program Outcomes (POs)

- **PO 1: Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO 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.
- **PO 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.
- **PO 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.
- **PO 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.
- **PO 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.
- **PO 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.
- **PO 8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO 9: Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO 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.
- **PO 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.
- **PO 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.



OBE Framework of the Institute



Revised Bloom's Taxonomy (BT)

The cognitive process dimensions- categories					
Lower Order of Thinking (LOT)			**Higher Order of Thinking (HOT)**		
Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Recognizing (identifying) Recalling (retrieving)	Interpreting Illustrating Classifying Summarizing Inferring (concluding) Comparing Explaining	Executing Implementing	Differentiating Organizing Attributing	Checking (coordinating, detecting, testing, monitoring) Critiquing (judging)	Planning Generating Producing (constructing)

The Knowledge Dimension			
Concrete Knowledge → **Abstract knowledge**			
Factual	**Conceptual**	**Procedural**	**Metacognitive**
• Knowledge of terminologies • Knowledge of specific details & elements	• Knowledge of classifications and categories • Knowledge of principles & generalizations • Knowledge of theories, models & structures	• Knowledge of subject specific skills and algorithms • Knowledge of subject specific techniques and methods • Knowledge of criteria for determining when to use appropriate procedures	• Strategic Knowledge • Knowledge about cognitive task, including appropriate contextual and conditional Knowledge • Self- Knowledge

Action Verbs for Course Outcomes

Sample Action verbs:

Lower Order of Thinking (LOT)			Higher Order of Thinking (HOT)		
Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Define	Explain	Solve	Analyse	Reframe	Design
Describe	Describe	Apply	Compare	Criticize	Create
List	Interpret	Illustrate	Classify	Judge	Plan
State	Summarise	Calculate	Distinguish	Recommend	Formulate
Match	Compare	Sketch	Explain	Grade	Invent
Tabulate	Discuss	Prepare	Differentiate	Measure	Develop
Record	Estimate	Chart	Appraise	Test	Organize
Label	Express	Choose	Conclude	Evaluate	Produce

Illustration (use of action verb w.r.t knowledge dimension and order of thinking):

Use of action verbs	Factual	Conceptual	Procedural	Metacognitive
Remember	**List** properties of soil	**Recognize** characteristic of material	**Explain** working of pump	**Identify** strategies for report writing
Understand	**Summarize** features of a new product.	**Classify** adhesives by toxicity.	**Explain** assembly instructions.	**Predict** the behavior of member
Apply	**Respond** to frequently asked questions.	**Provide** advice to team members	**Carry out** pH tests of water samples.	**Use** modern techniques to get solution
Analyse	**Explain** the selection of tool/ activity.	**Differentiate** LOT and HOT	**Integrate** compliance with regulations.	**Assess** the project work
Evaluate	**Select** the appropriate tool	**Determine** relevance of results.	**Judge** efficiency of sampling techniques.	**Reflect** on one's progress.
Create	**Generate** a log of daily activities.	**Assemble** a team of experts.	**Design** efficient project workflow.	**Create** a learning portfolio.

Guidelines for writing Course Outcome Statements

Well-written course outcomes involve the following parts:

1. Action verb
2. Subject content
3. Level of achievement as per BTL
4. Modes of performing task (if applicable)

Illustration:

Students are able to

1) Design column splices and bases. → Action verb (underlined)

2) Determine the losses in a flow system. → Subject content

3) Use structural analysis software to a competent Level. → level of achievement

4) Present seminar on real life problems. → Modes of performing task with action verb (underlined)

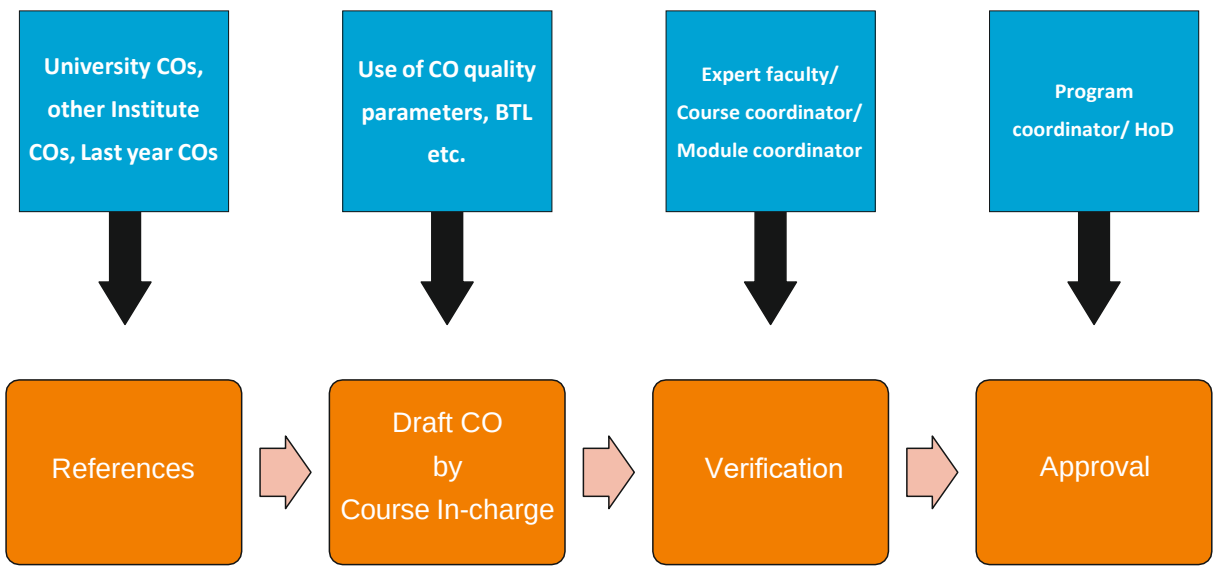
While writing COs the following questions/points must be addressed properly.

Specific	Is there a description of precise behavior and the situation it will be performed in? Is it concrete, detailed, focused and defined?
Measurable	Can the performance of the outcome be observed and measured?
Achievable	With a reasonable amount of efforts and application can the outcome be achieved? Are you attempting too much?
Relevant	Is the outcome important or worthwhile to the learner or stakeholder? Isit possible to achieve this outcome?
Time-Bound	Is there a time limit, rate, number, percentage or frequency clearly stated? When will this outcome be accomplished?

Note: If Laboratory is given as separate course (with course code) then there should be separate course outcomes for Laboratory.

Quality of Course Outcome

Process at department level to maintain quality of CO



Guidelines/Checklist for COs:

Number of COs	2 to 4
CO essentials	Action Verb, Subject Content, Level of Achievement, Modes of Performing task (If Applicable)
Based on BTL	Understand, Remember, Apply, Analyse, Evaluate, Create
Number of BTL Considered in one course	Minimum 3
Technical Content/ point of curriculum	All curriculum contents are covered
Curriculum gap	Additional CO for gap identified/filling. Adds more weightage

CO-PO Mapping Guidelines

CONSIDER ANY TWO MINIMUM CRITERIA FOR CO-PO MAPPING JUSTIFICATION

A] Contact Hours: Lecture, Tutorial and Practical

Level	Contact Hours in Percentage (including Lecture, Tutorial & Practical)
No mapping (-)	< 5%
Low (1)	5- 15%
Medium (2)	15- 25%
High (3)	>25%

Description

Number of Lectures = 3per week x 12 weeks = 36 Hours
Tutorial = 1Hr x 12 Weeks = 12 Hours
Practical = 2Hr x 12 Week = 24 Hours
Total Hrs = 36+12+24 = 72 Hrs
Example: Let, CO1 related points are engaged in 10 lectures + 1 Tutorial and 2 practical Hours
Then contact hours = 10+1+2x2 = 15 hours
Therefore, contact hours in percentage = (15/72) x 100 = 20.8 %. Medium mapping (2)

B] Number of Assessment Tools used

Level	Assessment tools used to assess the CO
No mapping (-)	0
Low (1)	1 or 2
Medium (2)	3
High (3)	4 or more

Description

CO assessment tools: Mid-term test, end term test, class test, surprise test, oral, continuous internal assessment (Assignment, Lab practical assessment), course exit survey, University theory exam, oral exam/ practical oral exam, external feedback, Activities (Survey, guest lecture, workshop, seminar, casestudies, mini/minor projects etc.)
Every CO must be correlated with each PO and appropriate mapping may be selected.

C] Key words

Most of the times, appropriate keyword is sufficient for mapping.

Level	Keywords Used in writing COs
No mapping (-)	Key words related with LOT and not related with course or any outcomes
Low (1)	Part of PO is reflected through keywords/action verbs
Medium (2)	Major part of PO is reflected through keywords/action verbs. + moderate level performance is expected from student to achieve PO
High (3)	Exact action verb of PO + critical performance expected from student to achieve PO

D] Critical Assessment Record for PO5 to PO12

Level	Assessment Depth
No mapping (-)	No rubric used for assessment
Low (1)	Single rubric category used for assessment
Medium (2)	Two rubric category used for assessment
High (3)	Three or more rubric category used for assessment

Illustration

Category No.	Rubric Category	Level of Performance			
		4	3	2	1
1	Group Leader	Seeks opportunities to lead; while leading is attentive to each member	Will take lead if group insists; not good at being attentive to each member	Resists taking on leadership role; while leading allows uneven contributions	Never shows up
2	Contribution	Always contributes; quality of contributions is exceptional	Sometimes contributes; quality of contributions is fair	Rarely contributes; contributions are often peripheral or irrelevant; frequently misses team sessions	Never shows up and never contributes.
3	Cooperation	Always cooperative with all members, support good initiatives	cooperative with members, but sometimes argue	cooperative with few members, and argue most of time	Non-cooperative

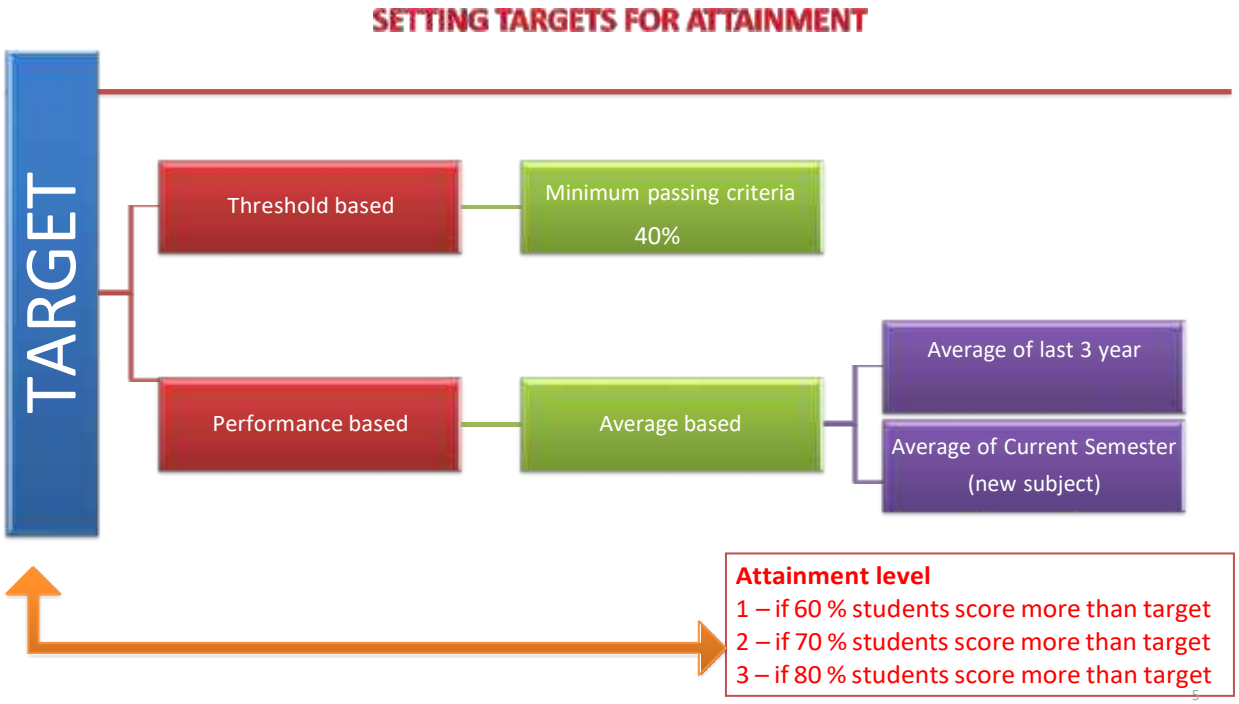
E] Assessment Type

Level	Assessment Depth
No mapping (-)	Test items (1) **OR** Nil
Low (1)	Test items (2) **OR** Assessment item (1)
Medium (2)	Test items (2) + Assessment item (1) **OR** Assessment item (2)
High (3)	Test items (2) + Assessment item (2) and More

Test Item:
Mid-term, End term, class test, surprise test, University theory exam (Questions + additional information)
Assessment items:
Quizzes, Assignment problems, simulation, laboratory experiments, project, field work, report presentation, tutorials, activities, etc.

F] Any other criteria with proper justifiable document is acceptable.

Targets/ Attainment Levels

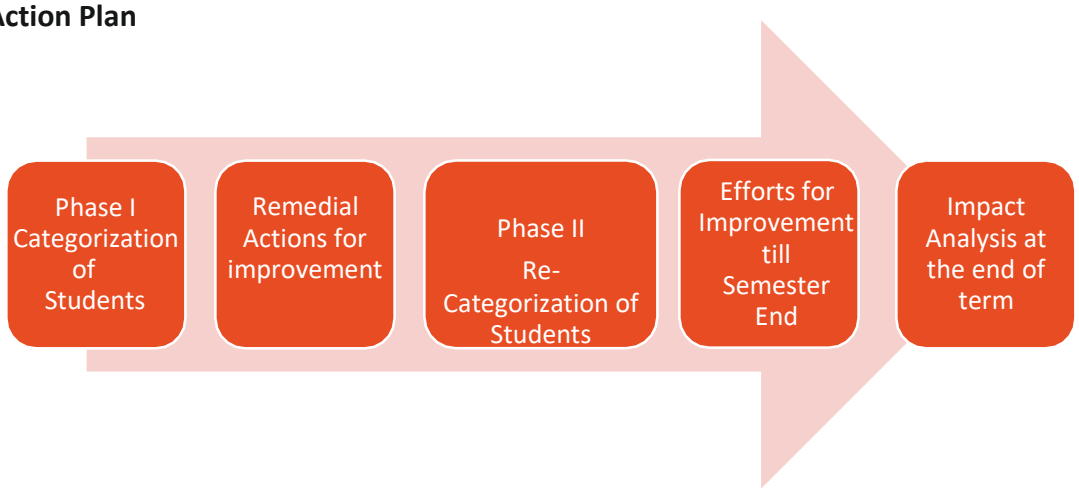


Illustration

Case of Course	Avg % result in last year/ 3 years	Clue for keeping target	Attainment 1 if	Attainment 2 if	Attainment 3 if
Course 1	<40 %	Threshold	40 % cross target	50% cross target	60% cross target
Course 2	Above 40% but less than 50%	Threshold with high attainment level	60 % cross target	70% cross target	80% cross target
Course 3	Above 50 %	Average based	40 % cross target	50% cross target	60% cross target
Course 4	Above 80 %	Average based with high attainment level	60 % cross target	70% cross target	80% cross target

Student Competency

Chart of Action Plan



Guidelines for First Year

Phase I- Categorization (After 15 Days of start of semester)	Phase II- Re-categorization (After Mid Term Result)
12th Marks	Mid Term Result
Prerequisite Test	Timely Completion of work
Surprise Test after 15 days	Lab Performance
Attendance & Behavior	Attendance & Behavior
	Previous Semester University Result (Applicable for Sem-II)

Guidelines for Higher Classes [SY, TY & BE]

Phase I- Categorization (After 15 Days of start of semester)	Phase II- Re-categorization (After Mid Term Result)
Previous semester University Result whichever is available	Mid Term Result
Prerequisite Test	Timely Completion of work
Surprise Test after 15 days	Lab Performance
Attendance & Behaviour	Attendance & Behavior
	Previous semester University Result

Base Score for student category

<50% -Slow Learner

50% to 65% - Average Learner

>65%-Advanced Learner

Strategies for Slow, Average and Advanced Learners

For Slow learners

- Document/record of remedial classes with timetable & attendance
- Specially designed assignment/ task
- Student study group for peer to peer learning
- Individual Counseling
- Student help desk

Note: Remedial sessions should be conducted once every week.

For Average Learners

- Additional assignment/ task
- Encouraging for timely and effective completion of work
- Conduction of quiz, orals etc.
- Solving previous year University question papers and test papers
- Presentation on technical topics/ case studies/mini projects

Note: Activities should be on continuous basis.

For Advanced Learners

- Encouraging to present & publish papers in journals/conferences/competitions
- Guidance for GATE/ competitive Examination
- Encouraging to participate in professional activities.
- Specially designed activities to improve the portfolio of students.
- Individual guidance for career building

Note: Activities should be on continuous basis.

Rubrics for Assessment

What is Rubric?

- A scoring guide with criteria for evaluating students' work in direct relation to one or more of the PO's and a rating scale indicating differing levels of performance.

Rubrics are:

- Used to examine how well students have met CO or PO rather than how well they perform compared to their peers.
- Typically include measurable descriptors that define expectations at each level of performance for each criterion.

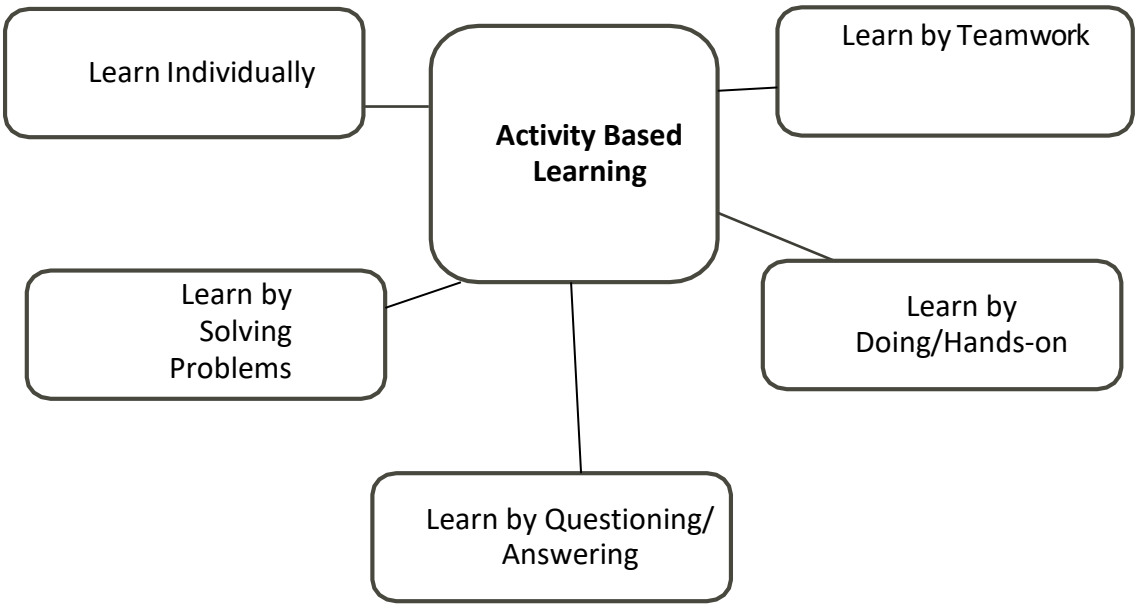
Sample Rubrics for CO assessment in Laboratory: (10 Marks)

Category	Level of Performance		
	3 marks	**2 marks**	**1 marks**
Performance in Lab (3)	• Able to perform experiment independently within prescribed time • The result is close or to standard value.	• Able to perform experiment within prescribed time • Large deviation of result from standard value	• Able to perform the experiment partially with no results.
Level of Understanding / Q&A (3)	• Able to show strong theoretical background of experiment • Able to interpret proper data to reach conclusion	• Partially show strong theoretical background of experiment • Partially able to interpret data to reach conclusion.	• Lack of theoretical background of experiment or lack of interpretation of data
	Documentation Level		
	4 marks	**3 marks**	**2 marks**
Quality of Submission (4)	• Graphs, table, contents are well constructed. • All-important calculations and result have been clearly made. • Conclusions/ observations/ comments done clearly	• Shortfalls found in any of the contents of the report viz. graphs, tables, calculations, results, conclusions/ Comments, etc.	• Report submitted but not written properly.

Rubric maximum score = 4+3+3 (high marks) = 10 (100%)

Rubric minimum score = 1+1+2 (low marks) = 4 (40%)

Activity Based Learning



Examples:

MOOC, Flipped Classroom, Think Pair Share, Think Pair Solo, Four Corners, Round Robin, Collaborative Learning, Jig-Saw Puzzle, Matrix Method, Peer Learning, Work-Based Learning, Problem-Based Learning, Personalized Learning, Group Discussion, Debate, Case Studies, Fish Bowl, Reciprocal Teaching, etc.

List of Assessment Tools

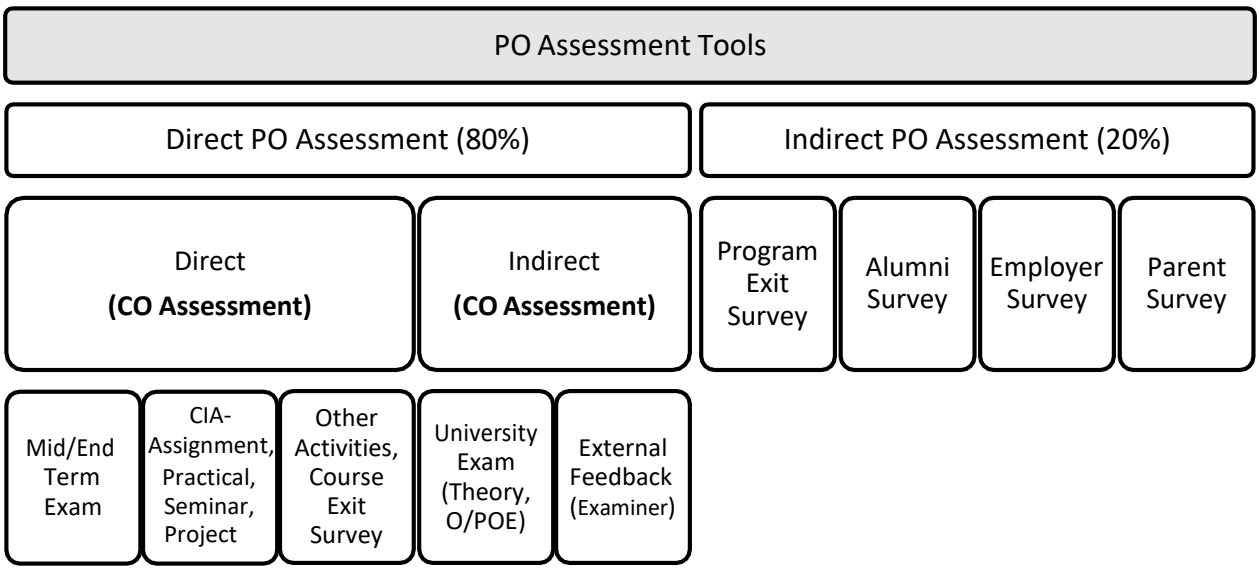
All (Direct + Indirect) CO Assessment Tools = PO Direct Assessment Tools

Sample CO Assessment Tools

- Mid Term Test
- End Term Test
- Quiz
- Assignment
- Practical/ Lab work
- Industrial Visit, Workshop
- Other Task/Activity
- University Exam
- Oral/POE
- Course Exit Survey
- External Feedback (External Examiner/Trainer, Campus Placement Technical Expert)

Direct Tools: (Measurable in terms of marks and w.r.t. CO) Assessment done by faculty at Institute level

Indirect Tools: (Non measurable in terms of marks and w.r.t. CO) Assessment done at University Level



Sample Indirect PO assessment Tools

- Program Exit Survey
- Alumni Survey
- Employer Survey of Alumni
- Parent Feedback

CO Attainment Calculations

Attainment Weightage:

Consider following weightage for PO Assessment Tools

PO Assessment Tools	
Direct PO Assessment (80%)	Indirect PO Assessment (20%)

Consider following weightage for CO Assessment Tools

PO Direct Assessment Tools = CO Assessment Tools		
Direct CO Assessment	**Indirect CO Assessment**	
20	80	University BE Curriculum
60	40	University CBCS (from 2018 FY batch)

Illustration of Internal Test Examination Attainment:

Course	Engg. Mathematics
Maximum Marks	30
Number of Students Appeared	60
Passing Level (Threshold Based Target)	12 (40% here)

Now, we need target (mentioned above in table) and marks of all students to calculate attainment. The table below shows marks of all students

5	23	5	11	21	0
0	12	5	2	7	4
0	22	3	3	10	7
5	18	9	20	17	24
23	8	25	16	9	10
12	2	8	11	22	4
26	13	2	1	30	19
24	22	16	10	1	2
12	21	8	25	11	4
24	9	22	20	20	17

Now

Number of student achieving 12 or more marks	28
% of students achieving 12 or more marks	(28/60)*100 = 46.6%

1 – if 40 % students score more than target

2 – if 50 % students score more than target

3 – if 60 % students score more than target

Then Attainment is = 1 (from 46.6%)

Illustration of Feedback/Rubric Based Assessment & Attainment

Course	SOM
Maximum Marks	5
Number of Students Appeared	60
Passing Level (Threshold Based Target)	3 (>50% here)

Now, we need target (mentioned above in table) and response/feedback of all students to calculate attainment. The table below shows score/response of all students

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

Now

Number of student giving 3 or more score	37
% of students with 3 or more marks	(37/60)*100 = 61.7%

1 – if 40 % students score more than target

2 – if 50 % students score more than target

3 – if 60 % students score more than target

Then attainment is = 3 (from 61.7%)

***

Overall Attainment of CO

Let's assume CO1 is assessed using any 2 direct + 2 Indirect CO assessment tools, then

A. Overall CO Attainment = (Weightage x Direct CO attainment) + (Weightage x Indirect CO attainment)

For University regular BE Curriculum and

B. Overall CO Attainment = (20 % x Direct CO attainment) + (80% x Indirect CO attainment)

For University CBCS Pattern,

C. Overall CO Attainment = (60 % x Direct CO attainment) + (40% x Indirect CO attainment) for Autonomous Pattern

 # Note: Appropriate % weightage distribution may be considered for any number of direct/indirect assessment tools with proper justification at department/faculty level.

Illustration

Course CO	PO											PSO			BTL
	1	2	3	4	5	6	8	9	10	11	12	1	2	3	
C202.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	Remember
C202.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	Understand
C202.3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	Apply
C202.4	-	3	-	-	-	-	-	-	-	-	-	-	-	-	Apply
C202.5	-	-	3	-	2	-	-	-	-	-	2	-	-	-	Analyse
C202.6	-	-	-	-	3	2	-	-	-	-	-	3	-	-	Analyse

So we finalize this assessment tools and then weightages

CO1 to CO4: Midterm & or end term + Continuous assessment (Assignment) + UE (PO1, 2)

CO5: Mid & or End term + Assignments **+ Activity (rubric for PO5, 12)** + UE (PO3)

CO6: Mid & or End term + Assignments **+ Activity (rubric for PO5, 6)** + UE (PSO1)

Sample List of Activities with BTL

Activities	Possible BTL	PO Mapping
Tutorial- Write-ups	Understand, Apply	Any relevant PO from 1 to 4
Practical-Experiments	Understand, Apply, Analyse, Evaluate, Create	Any Relevant PO
Test/Quiz	Understand, Apply, Analyse	Any relevant PO from 1 to 4
Students' Seminar	Understand, Apply, Analyse	Any PO from 1, 2, 8, 10
Case Study	Understand, Apply, Analyse	Any Relevant PO
Presentation/Oral	Understand	
Guest Lecture	Understand	
Visits	Understand	
Survey & Analysis	Apply & Analyse	
Workshop/Hands-on Training	Apply, Analyse, Evaluate	
Task	Evaluate, Create	
Minor Project	Create	

Note: Faculty/ department can conduct other than the mentioned activities with BTL, PO and proper justification.

Activity Planning Guidelines (PO5 to PO12)

Sr. No.	Activity	Contact Hours	Minimum Assessment Tool	Mapping Level
1	Seminar Presentation	1 to 6 hrs	Feedback or Quiz or Rubric Based Assessment	1
	Case Study			
	Guest Lecture			
	Visits			
	Survey & Analysis			
2	Visits	7 to 20 Hrs	i) Feedback or Quiz	2
	Survey & Analysis		ii) Rubric Based Assessment for Report, Presentation etc.	
	Workshop / Hands -on Training			
	Task			
3	Workshop/Hands - on Training	More than 20 Hrs	i) Feedback or Quiz	3
	Task		ii) Rubric Based Assessment for each PO	
	Minor Project		iii) Impact analysis	

Note: Department may use other additional criteria and justify the mapping level.

Contribution of Course Attainment in PO Attainment

Illustration

Let us assume CO-PO mapping of a course

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	2	1	-	-	-	-	-	-	-	-	-	3	-	-
3	-	3	1	-	-	-	-	-	-	-	-	-	3	-	-
4	-	3	-	2	-	-	-	-	-	-	-	1	3	-	-
Average	3	3	1	2	-	-	-	-	-	-	-	1	3	-	-

Overall Attainment of CO is as below

CO	Direct Tool Attainment (A)	Indirect Tool Attainment (B)	Overall CO Attainment = 0.2x A + 0.8 x B
1	2	3	2.8
2	3	3	3
3	2	3	2.8
4	1	3	2.6

Hence, final contribution of CO attainment in PO attainment can be done using the below formula,
CO Contribution = Overall CO attainment X (CO-PO Mapping weightage / 3)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	2.00	1.00	-	-	-	-	-	-	-	-	-	3.00	-	-
3	-	2.80	0.93	-	-	-	-	-	-	-	-	-	2.80	-	-
4	-	2.60	-	1.73	-	-	-	-	-	-	-	0.86	2.60	-	-
Average	2.80	2.50	0.96	1.73	-	-	-	-	-	-	-	0.86	2.80	-	-

Sample calculations:

CO1- PO1 mapping attainment 2.8 x 3/3 = 2.80 (up to 2 decimal places)
CO2- PO2 mapping attainment 3 x 2/3 = 2.00
CO2- PO3 mapping attainment 3 x 1/3 = 1.00
CO3- PO3 mapping attainment 2.8 x 1/3 = 0.93
CO4- PO12 mapping attainment 2.6 x 1/3 = 0.86

Continuous Improvement

A) Contribution of CO in PO attainment and Continuous Improvement (Faculty Level)

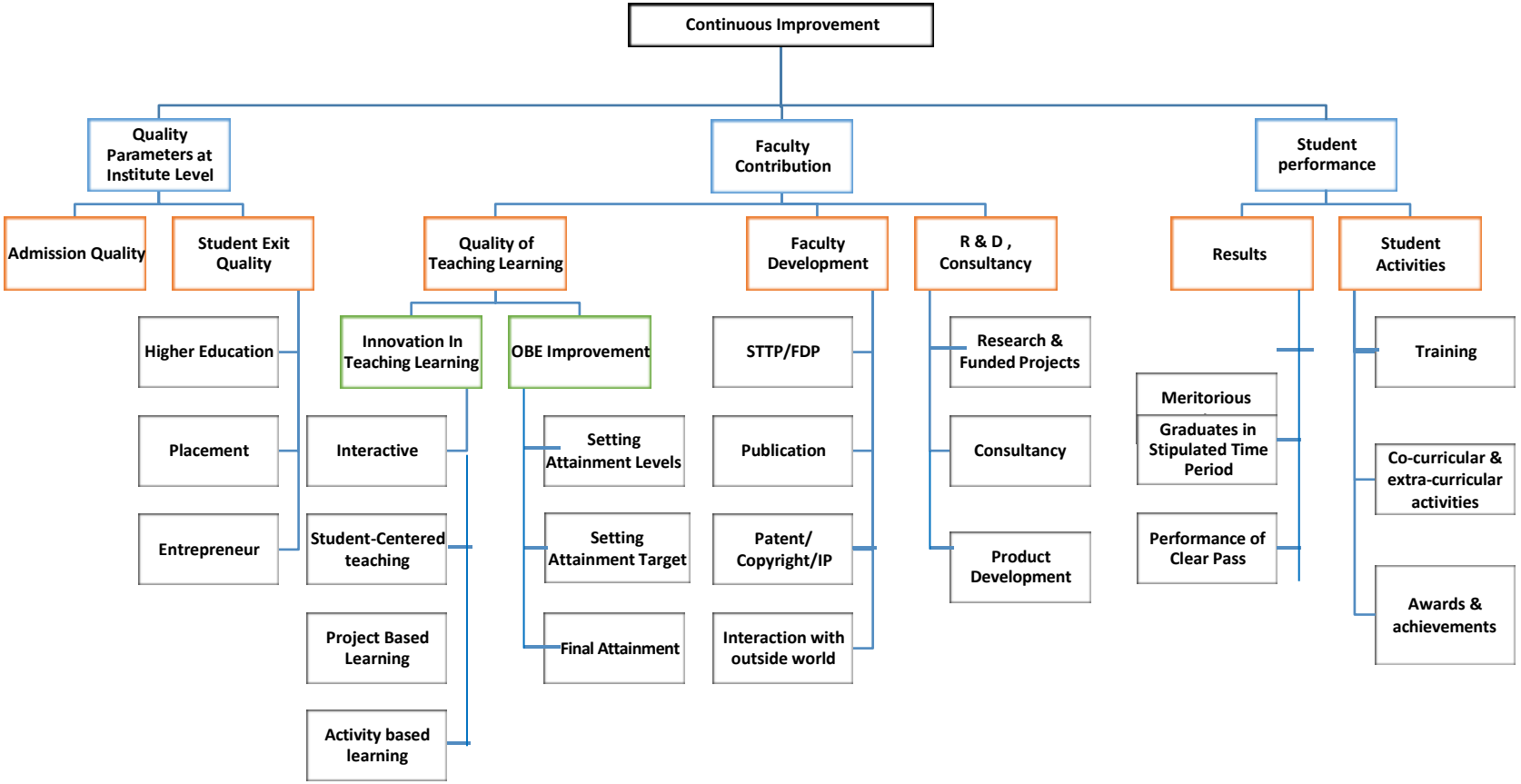
Outcome	Action to be taken by faculty
High attainment of all CO-PO (>2.5 out of 3)	Set new higher targets or attainment levels for next Academic Year (A.Y.).
Moderate attainment of all CO-PO (1.8 to 2.49 out of 3)	Record observations, Continue action plan of last A.Y. with plan for improvements.
Low attainment of all CO-PO (0.9 to 1.79 out of 3)	Record observations, assess the target set, revise/improve action plan of last A.Y. to achieve the attainment with plan for improvements.
CO-PO not attained, poor performance(<0.9 out of 3)	Record observations, Critical assessment of target with Program Assessment Committee (PAC), Revise action plan of last A.Y. at faculty/department level.

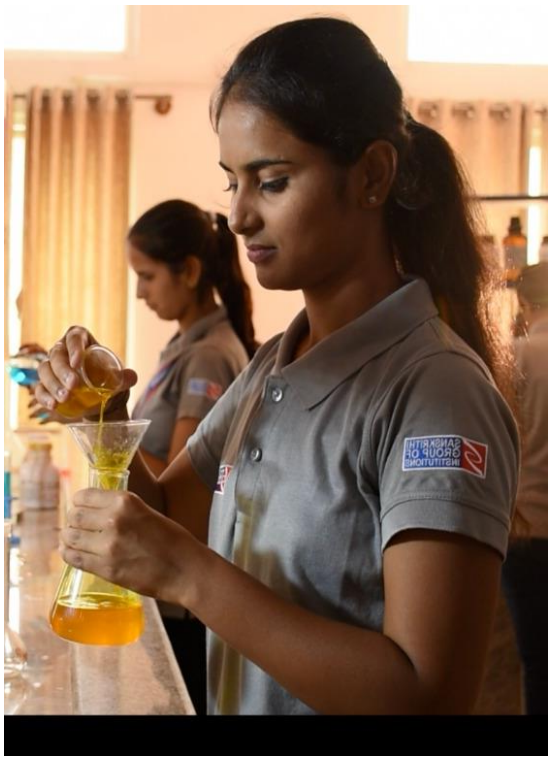
B) PO attainment and Continuous Improvement (PC and HoD Level)

Category	Outcome	Action by PC and HoD
Course related	PO attained highly	Include activities with HOT.
	PO not attained highly	Identify concerned courses, plan for immediate improvements, guide, support and monitor its execution.
Activity related	Activities Conducted	Critical assessment, impact analysis to be done and revise as per the need for improvements.

List of Documents

Sr.	Title	Details
1	Vision, Mission of Institute	Maintain at Dept. Level (PC & HoD)
2	Vision, Mission of Program	Maintain at Dept. Level (PC & HoD)
3	PEO of Program, PEO-PO/PSO Mapping	Maintain at Dept. Level (PC & HoD)
4	PO and PSO of Program	Maintain at Dept. Level (PC & HoD)
5	CO + PO/PSO + Mapping	Maintained by every faculty in Course File
6	Revised Bloom's Taxonomy Level and OBE Framework	Print to be maintained in Course File of Faculty & displayed in department all labs
7	Course List with Course Codes	Maintain at Dept. Level (PC & HoD)
8	List of PO Assessment Tools	Maintain at Dept. Level (PC & HoD)
9	List of CO Assessment Tools Used	Maintained by every faculty in Course File
10	Program Assessment Committee & DAB	Maintain at Dept. Level (PC & HoD)
11	Course and Module Coordinators	Maintain at Dept. Level (PC & HoD)
12	Course Plan	Along with delivery details and assessment tools by Faculty
13	Attainment Levels/ Targets of all courses of your program	Maintained by every faculty in Course File
14	Rubrics	Course wise rubrics to be maintained by every Faculty All activity rubrics to be maintained at Dept. Level (PC & HoD)
15	Record of all Assessment Details	Test Papers, Model Answers, Sample Answer Papers, Results, Sample Journals of students, Lab Manuals, Sample Seminar, Project Report & other record concerned with assessment to be maintained by Faculty
16	Slow-Advanced Learners	Identification, Action Taken Record to be maintained by Faculty
17	Course Exit Survey of every course	To be maintained by concerned Faculty
18	Program Exit Survey, Alumni Feedback, Employer Feedback	End of Final Year: Maintain at Dept. Level (PC & HoD)
19	CO Attainment	At End of Course: Maintained by Faculty and to be submitted to department
20	PO Attainment	At end of A.Y.: (Direct + Indirect) to be maintained by PC & HoD at Dept. Level
21	Impact Analysis and Continuous Improvement Related Documents	CO level documents to be maintained by concerned faculty. PO level documents to be maintained by PC and HoD.


Continuous Improvement
Quality Parameters at Institute Level
Faculty Contribution
Student performance
Admission Quality
Student Exit Quality
Quality of Teaching Learning
Faculty Development
R & D , Consultancy
Results
Student Activities
Higher Education
Placement
Entrepreneur
Innovation In Teaching Learning
OBE Improvement
Interactive
Student-Centered teaching
Project Based Learning
Activity based learning
Setting Attainment Levels
Setting Attainment Target
Final Attainment
STTP/FDP
Publication
Patent/ Copyright/IP
Interaction with outside world
Research & Funded Projects
Consultancy
Product Development
Meritorious
Graduates in Stipulated Time Period
Performance of Clear Pass
Training
Co-curricular & extra-curricular activities
Awards & achievements



Vision

To develop dynamic and socially responsible engineers possessing wisdom, positive attitude, and an impeccable character.

Mission

1. The college is devoted to serving society and the nation by providing quality education, and skill development programs thereby enabling the students to become skilled engineers with the right kind of knowledge.

2. Committed towards setting new benchmarks of excellence in engineering education with emphasis on research & development, innovation and services to society, industry, and the world.

Quality Policy

We at Sanskrit School of Engineering endeavour to uphold excellence in all spheres by adopting best practices in effort and effect.

www.instagram.com/sanskrithigroup_ptp/

SSE
Driven by Creativity & Innovation

SANSKRITHI SCHOOL
OF ENGINEERING
PUTTAPARTHI

CONTACT DETAILS

Official Website: Sanskrithi School of Engineering (sseptp.org)
Official Instagram : https://www.instagram.com/sanskrithigroup_ptp/
Official Twitter: @SanskrithiGroup
Official Facebook Page Link: https://www.facebook.com/sseptp/
Phone - +91 9100064545/9100074545/9100974528/30/44

DEPARTMENT OF MECHANICAL ENGINEERING

Vision:

To establish ourselves as a leading institution that equips engineers, researchers, entrepreneurs, and managers in the field of Mechanical Engineering with the skills necessary to thrive on a global scale.

Mission:

Our mission is to provide high-quality education through experiential learning, utilizing ICT tools and engaging in socially relevant projects. We aim to involve both faculty and students in fundamental, heavy engineering, and applied research focused on addressing energy, environmental, and safety concerns. Furthermore, we strive to nurture and prepare our students to excel as successful entrepreneurs and managers.

Programme Educational Objectives (PEOs):

The B. Tech (MECH) programme aims to achieve the following Program Educational Objectives:

PEO1: Graduates will demonstrate adaptability to emerging technological challenges while possessing core competence in the field of mechanical engineering.

PEO2: Graduates will effectively apply their technical knowledge and skills to secure suitable positions within various technological organizations, as well as to succeed as entrepreneurs.

PEO3: Graduates will pursue advanced studies in key areas of mechanical engineering, enabling them to conduct scientific and industrial research ethically to meet the current demands of their respective sectors.

Programme Outcomes (POs):

PO1: Engineering Knowledge: Effectively apply a comprehensive understanding of mathematics, science, engineering fundamentals, and specialized knowledge in a specific engineering discipline to solve intricate and multifaceted engineering problems.

PO2: Problem Analysis: Skilfully identify, formulate, conduct extensive research, and analyze complex engineering problems, arriving at well-supported conclusions based on the fundamental principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Proficiently design innovative solutions for intricate engineering problems, incorporating system components or processes that fulfil specified requirements while demonstrating due regard for public health and safety, as well as the cultural, societal, and environmental considerations.

PO4: Complex Problem Investigations: Utilize research-based knowledge and methodologies, including experimental design, data analysis, interpretation, and synthesis, to conduct thorough investigations into complex problems, resulting in valid and well-founded conclusions.

PO5: Utilization of Modern Tools: Develop, select, and employ appropriate techniques, resources, as well as cutting-edge engineering and IT tools, including prediction and modelling, to effectively address complex engineering activities while understanding their limitations.

PO6: Engineer and Society: Employ reasoning grounded in contextual knowledge to evaluate societal, health, safety, legal, and cultural aspects, while recognizing the associated responsibilities inherent in professional engineering practice.

PO7: Environment and Sustainability: Comprehend the impact of professional engineering solutions within societal and environmental contexts, while demonstrating a profound understanding of the necessity for sustainable development.

PO8: Ethics: Apply ethical principles, adhering to professional ethics, responsibilities, and norms embedded within engineering practice.

PO9: Individual and Teamwork: Demonstrate effective performance both as an individual and as a member or leader in diverse teams, as well as in multidisciplinary settings.

PO10: Communication: Effectively communicate complex engineering activities to both the engineering community and society at large. This includes the ability to comprehend and produce comprehensive reports and design documentation, deliver impactful presentations, and provide and receive clear instructions

PO11: Project Management and Finance: Demonstrate a comprehensive understanding of engineering and management principles, applying them to one's own work, as well as functioning as a member and leader in a team, to effectively manage projects in multidisciplinary environments.

PO12: Lifelong Learning: Recognize the importance of ongoing learning and possess the necessary preparation and ability to engage in independent and lifelong learning within the broad context of technological advancements and changes.

Programme Specific Outcomes (PSOs):

Engineering graduates will have the ability to:

PSO1: Employ modern tools and technologies for the design, analysis, and manufacturing of mechanical components and systems.

PSO2: Effectively address and solve complex, multidisciplinary problems encountered in manufacturing and related industries.

Semester - 1 (Theory - 5, Lab - 4)					
S.No	**Course No**	**Course Name**	**Category**	**L-T-P**	**Credits**
1.	20A54101	Linear Algebra and Calculus	BS	3-0-0	3
2.	20A51201T	Engineering Chemistry	BS	3-0-0	3
3.	20A05201T	C-Programming & Data Structures	ES	3-0-0	3
4.	20A02101T	Basic Electrical & Electronics Engineering	ES	3-0-0	3
5.	20A03202	Engineering Workshop	ES	0-0-3	1.5
6.	20A05202	IT Workshop	ES	0-0-3	1.5
7.	20A51201P	Engineering Chemistry Lab	BS	0-0-3	1.5
8.	20A05201P	C-Programming & Data Structures Lab	ES	0-0-3	1.5
9.	20A02101P	Basic Electrical & Electronics Engineering Lab	ES	0-0-2	1.5
				Total	**19.5**

Semester – 2 (Theory – 5, Lab – 5)					
S.No	**Course No**	**Course Name**	**Category**	**L-T-P/D**	**Credits**
1.	20A54201	Differential Equations and Vector Calculus	BS	3-0-0	3
2.	20A56101T	Engineering Physics	BS	3-0-0	3
3.	20A52101T	Communicative English	HS	3-0-0	3
4.	20A03201T	Material Science & Engineering	ES	3-0-0	3
5.	20A03101T	Engineering Drawing	ES	1-0-0/2	2
6.	20A03101P	Engineering Graphics Lab	ES	0-0-2	1
7.	20A52101P	Communicative English Lab	HS	0-0-3	1.5
8.	20A56101P	Engineering Physics Lab	BS	0-0-3	1.5
9.	20A03201P	Material Science Lab	ES	0-0-3	1.5
10	20A52201	Universal Human Values	MC	3-0-0	0.0
				Total	**19.5**

Semester-III							
S. No.	**Course Code**	**Course Name**	**Category**	**Hours per week**			**Credits**
				L	**T**	**P**	
1.	20A54303	Complex variables, Transforms and Application of PDE	BS	3	0	0	3
2.	20A01302T	Fluid Mechanics & Hydraulic Machines	PC	3	0	0	3
3.	20A03301T	Manufacturing Processes	PC	3	0	0	3
4.	20A03302	Thermodynamics	PC	3	0	0	3
5.	20A01305T	Mechanics of Materials	ES	3	0	0	3
6.	20A01302P	Fluid Mechanics &Hydraulic MachinesLab	PC	0	0	3	1.5
7.	20A03301P	Manufacturing Processes Lab	PC	0	0	3	1.5
8.	20A01305P	Mechanics of Materials Lab	ES	0	0	3	1.5
9.	20A05305	**Skill oriented course – I** Application Development with Python	SC	1	0	2	2
10.	20A99201	**Mandatory noncredit course – II** Environmental Science	MC	3	0	0	0
Total							**21.5**

Course Code	Linear Algebra and Calculus		L	T	P	C
20A54101			3	0	0	3
Pre-requisite	Linear Algebra and Calculus	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Develop the use of matrix algebra techniques that is needed by engineers for practicalapplications
CO2	Utilize mean value theorems to real life problems
CO3	Familiarize with functions of several variables which is useful in optimization
CO4	Students will also learn important tools of calculus in higher dimensions.
CO5	Students will becomefamiliar with 2- dimensional coordinate systems
CO6	Students will become familiar with 3- dimensional coordinate systems and also learn theutilization of special functions

UNIT – I 9 Hrs

Matrices

Rank of a matrix by echelon form, normal form. Solving system of homogeneous and non-homogeneous equations linear equations. Eigen values and Eigenvectors and their properties, Cayley- Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalisation of a matrix.

UNIT – II 9 Hrs

Mean Value Theorems

Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof) related problems.

UNIT – III 9 Hrs

Multivariable Calculus

Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

UNIT – IV 8 Hrs

Multiple Integrals

Double integrals, change of order of integration, change of variables. Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates. Finding areas and volumes using double and triple integrals.

UNIT – V 9 Hrs

Beta and Gamma functions

Beta and Gamma functions and their properties, relation between beta and gamma functions,evaluation of definite integrals using beta and gamma functions.

Course Code	Engineering Chemistry		L	T	P	C
20A51201T			3	0	0	3
Pre-requisite	Chemistry	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate the corrosion prevention methods and factors affecting corrosion
CO2	Explain the preparation, properties, and applications of thermoplastics & thermosetting,elastomers & conducting polymers
CO3	Explain calorific values, octane number, refining of petroleum and cracking of oils
CO4	Explain the setting and hardening of cement and concrete phase
CO5	Summarize the concepts of colloids, micelle and nanomaterials

UNIT – I 9 Hrs

Water Technology:

Introduction –Soft Water and hardness of water, Estimation of hardness of water by EDTA Method - Boiler troubles –Priming, foaming**,** scale and sludge, Caustic embrittlement, Industrial water treatment specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT – II 9 Hrs

Electrochemistry and Applications:

Electrodes – concepts, electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad),and lithium ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygen, methanol fuel cells – working of the cells.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, **Factors affecting the corrosion,** cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

UNIT – III 9 Hrs

Polymers and Fuel Chemistry:

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth and coordination polymerization. Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of poly styrene. PVC and Bakelite

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol

Fuels **–** Types of fuels, calorific value, numerical problems based on calorific value; Analysis of coal, Liquid Fuels refining of petroleum, fuels for IC engines, knocking and anti-knock agents, Octane and Cetane values, cracking of oils; alternative fuels- propane, methanol and ethanol, bio-fuels.

UNIT – IV 8 Hrs

Advanced Engineering Materials

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforcedcomposites, properties and Engineering applications

Refractories- Classification, Properties, Factors affecting the refractory materials and Applications. Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils – Viscosity, Viscosity Index, Flash point, Fire point, Cloud point, saponification and Applications.

Building materials- Portland Cement, constituents, phases and reactivity of clinker, Setting andHardening of cement.

UNIT – V 9 Hrs

Surface Chemistry and Applications:

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (any two methods with examples), chemical and electrochemical methods (not more than two methods) of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, solid- gas interface, solid-liquid interface, adsorption isotherm, BET equation (no derivation) applications of colloids and nanomaterials – catalysis, medicine, sensors.

Course Code	C-Programming & Data Structures		L	T	P	C
20A05201T			3	0	0	3
Pre-requisite	Maths	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Analyse the basic concepts of C Programming language
CO2	Design applications in C, using functions, arrays, pointers and structures
CO3	Apply the concepts of Stacks and Queues in solving the problems
CO4	Explore various operations on Linked lists
CO5	Demonstrate various tree traversals and graph traversal techniques
CO6	Design searching and sorting methods

UNIT – I 9 Hrs

Introduction to C Language - C language elements, variable declarations and data types, operators and expressions, decision statements - If and switch statements, loop control statements - while, for, do-while statements, arrays.

UNIT – II 9 Hrs

Functions, types of functions, Recursion and argument passing, pointers, storage allocation, pointers to functions, expressions involving pointers, Storage classes – auto, register, static, extern, Structures, Unions, Strings, string handling functions, and Command line arguments.

UNIT – III 9 Hrs

Data Structures, Overview of data structures, stacks and queues, representation of a stack, stack related terms, operations on a stack, implementation of a stack, evaluation of arithmetic expressions, infix, prefix, and postfix notations, evaluation of postfix expression, conversion of expression from infix to postfix, recursion, queues - various positions of queue, representation of queue, insertion, deletion, searching operations.

UNIT – IV 8 Hrs

Linked Lists – Singly linked list, dynamically linked stacks and queues, polynomials using singly linked lists, using circularly linked lists, insertion, deletion and searching operations, doubly linked lists and its operations, circular linked lists and its operations.

UNIT – V 9 Hrs

Trees - Tree terminology, representation, Binary trees, representation, binary tree traversals. Binary tree operations, **Graphs** - graph terminology, graph representation, elementary graph operations, Breadth First Search (BFS) and Depth First Search (DFS), connected components, spanning trees. **Searching and Sorting** – sequential search, binary

search, exchange (bubble) sort, selection sort, insertion sort.

Course Code	Basic Electrical & Electronics Engineering		L	T	P	C
20A02101T			3	0	0	3
Pre-requisite	Physics and Chemistry	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

Part A: Basic Electrical Engineering	
CO1	Explain the theory, construction, and operation of electronic devices.
CO2	Apply the concept of science and mathematics to explain the working of diodes and its applications, working of transistor and to solve the simple problems based on the applications.
CO3	Analyze small signal amplifier circuits to find the amplifier parameters
CO4	Design small signal amplifiers using proper biasing circuits to fix up proper Q point.
CO5	Distinguish features of different active devices including Microprocessors.
Part 'B'- Electronics Engineering	
CO1	Explain the theory, construction, and operation of electronic devices.
CO2	Apply the concept of science and mathematics to explain the working of diodes and its applications, working of transistor and to solve the simple problems based on the applications
CO3	Analyze small signal amplifier circuits to find the amplifier parameters
CO4	Design small signal amplifiers using proper biasing circuits to fix up proper Q point.
CO5	Distinguish features of different active devices including Microprocessors.

Part A: Basic Electrical Engineering

UNIT – I 9 Hrs

DC & AC Circuits:

Electrical circuit elements (R - L and C) - Kirchhoff laws - Series and parallel connection of resistances with DC excitation. Superposition Theorem - Representation of sinusoidal waveforms - peak and rms values - phasor representation - real power - reactive power - apparent power - power factor - Analysis of single-phase ac circuits consisting of RL - RC - RLC series circuits, Resonance.

UNIT – II 9 Hrs

DC & AC Machines:

Principle and operation of DC Generator - EMF equations - OCC characteristics of DC generator – principle and operation of DC Motor – Performance Characteristics of DC Motor - Speed control of DC Motor – Principle and operation of Single Phase Transformer - OC and SC tests on transformer - Principle and operation of 3-phase AC machines [Elementary treatment only]

UNIT – III 9 Hrs

Basics of Power Systems:

Layout & operation of Hydro, Thermal, Nuclear Stations - Solar & wind generating stations – Typical AC Power Supply scheme – Elements of Transmission line – Types of Distribution systems: Primary& Secondary distribution systems.

Part 'B'- Electronics Engineering

UNIT – I 8 Hrs

Diodes and Applications: Semiconductor Diode,Diode as a Switch& Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Operation and Applications ofZener Diode, LED, Photo Diode.

Transistor Characteristics: Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Biasing of Transistor Configuration; Field Effect Transistor (FET) – Construction, Characteristics of Junction FET, Concepts of Small Signal Amplifiers –CE & CC Amplifiers.

UNIT – II 9 Hrs

Operational Amplifiers and Applications: Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground; Op-Amp Applications - Inverting, Non- Inverting, Summing and Difference Amplifiers, Voltage Follower, Comparator, Differentiator, Integrator.

UNIT – III 9 Hrs

Digital Electronics: Logic Gates,Simple combinational circuits–Half and Full Adders, BCD Adder.Latches and Flip-Flops (S-R, JK andD), Shift Registers and Counters.Introduction to Microcontrollers and their applications (Block diagram approach only).

Course Code	Engineering Workshop		L	T	P	C
20A03202			0	0	3	1.5
Pre-requisite	Basic Maths	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Apply wood working skills in real world applications.
CO2	Build different objects with metal sheets in real world applications
CO3	Apply fitting operations in various applications.
CO4	Apply different types of basic electric circuit connections.
CO5	Use soldering and brazing techniques.

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LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Wood Working:** Familiarity with different types of woods and tools used in wood working and make following joints a) Half – Lap joint b) Mortise and Tenon joint c) Corner Dovetail joint or Bridle joint

2.	**Sheet Metal Working**: Familiarity with different types of tools used in sheet metal working, Developments of following sheetmetal job from GI sheets a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing
3.	**Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises a) V-fit b) Dovetail fit b) Semi-circular fit c) Bicycle tire puncture and change of two wheeler tyre
4.	**Electrical Wiring**: Familiarities with different types of basic electrical circuits and make the following connections a. Parallel and series b. Two way switch c. Go down lighting d. Tube light e. Three phase motor f. Soldering of wires

Course Code	IT Workshop		L	T	P	C
20A05202			0	0	3	1.5
Pre-requisite	Basic Maths, Basic Computer Knowledge	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Disassemble and Assemble a Personal Computer and prepare the computer ready to use.
CO2	Prepare the Documents using Word processors and Prepare spread sheets for calculations using excel and also the documents using LAteX.
CO3	Prepare Slide presentations using the presentation tool.
CO4	Interconnect two or more computers for information sharing.
CO5	Access the Internet and Browse it to obtain the required information.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Task 1:** **Learn about Computer:** Identify the internal parts of a computer, and its peripherals. Represent the same in the form of diagrams including Block diagram of a computer. Write specifications for each part of a computer including peripherals and specification of Desktop computer. Submit it in the formof a report.

2.	**Task 2:** **Assembling a Computer:** Disassemble and assemble the PC back to working condition. Students should be able to trouble shoot the computer and identify working and non-working parts. Student should identify the problem correctly by various methods
3.	**Task 3:** **Install Operating system:** Student should install Linux on the computer. Student may install another operating system (including proprietary software) and make the system dual boot or multi boot. Students should record the entire installation process.
4.	**Task 4**: **Operating system features**: Students should record the various features that are supported by the operating system(s) installed. They have to submit a report on it. Students should be able to access CD/DVD drives, write CD/DVDs, access pen drives, print files, etc. Students should install new application software and record the installation process. **Networking and Internet**
5.	**Task 5:** **Networking**: Students should connect two computers directly using a cable or wireless connectivity and share information. Students should connect two or more computers using switch/hub and share information. Crimpling activity, logical configuration etc. should be done by the student. The entire process has to be documented.
6.	**Task 6:** **Browsing Internet**: Student should access the Internet for Browsing. Students should search the Internet for required information. Students should be able to create e-mail account and send email. They should get acquaintance with applications like Facebook, skype etc. If Intranet mailing facility is available in the organization, then students should share the information using it. If the operating system supports sending messages to multiple users (LINUX supports it) in the same network, then it should be done by the student. Students are expected to submit the information about different browsers available, their features, and search process using different natural languages, and creating e- mail account.
7.	**Task 7:** **Antivirus:** Students should download freely available Antivirus software, install it and use it to check for threats to the computer being used. Students should submit information about the features of the antivirus used, installation process, about virus definitions, virus engine etc. **Productivity tools**
8.	**Task 8:** **Word Processor:** Students should be able to create documents using the word processor tool. Some of the tasks that are to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header and Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy and paste block of text, images, tables, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages, content sheet and chapter pages at the end of the task using the features studied. Students should submit a user manual of the word processor considered, Image Manipulation tools.
9.	**Task 9:** **Presentations:** creating, opening, saving and running the presentations, selecting the style for slides, formatting the slides with different fonts, colours, creating charts and

	tables, inserting and deleting text, graphics and animations, bulleting and numbering, hyperlinking, running the slide show, settingthe timing for slide show.
10.	**Task 10:** **Spreadsheet:** Students should be able to create, open, save the application documents and format them as per the requirement. Some of the tasks that may be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manualof the Spreadsheet.
11.	**Task 11:** **LateX:** Introduction to Latex and its installation and different IDEs. Creating first document using Latex, using content into sections using article and book class of LaTeX. Styling Pages: reviewing and customizing different paper sizes and formats. Formatting text (styles, size, alignment, colors and adding bullets and numbered items, inserting mathematical symbols, and images, etc.). Creating basic tables, adding simple and dashed borders, merging rows and columns. Referencing and Indexing: cross-referencing (refer to sections, table, images), bibliography (references).

Course Code	**Engineering Chemistry**		**L**	**T**	**P**	**C**
20A51201P			**0**	**0**	**3**	**1.5**
Pre-requisite	**Basic Chemistry**	**Semester**	**I**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Determine the cell constant and conductance of solutions
CO2	Prepare advanced polymer materials
CO3	Determine the physical properties like surface tension, adsorption and viscosity
CO4	Estimate the Iron and Calcium in cement
CO5	Calculate the hardness of water

LABORATORY EXPERIMENT LIST

S. No	**Title of the Experiments**
1.	Determination of Hardness of a groundwater sample.
2.	pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base
3.	Determination of cell constant and conductance of solutions
4.	Potentiometry - determination of redox potentials and emfs
5.	Determination of Strength of an acid in Pb-Acid battery
6.	Preparation of a polymer
7.	Determination of percentage of Iron in Cement sample by colorimetry
8.	Estimation of Calcium in port land Cement
9.	Preparation of nanomaterials by precipitation.
10.	Adsorption of acetic acid by charcoal
11.	Determination of percentage Moisture content in a coal sample
12.	Determination of Viscosity of lubricating oil by Redwood Viscometer 1 &2
13.	Determination of Calorific value of gases by Junker's gas Calorimeter

Course Code	**C-PROGRAMMING & DATA STRUCTURES**	**L**	**T**	**P**	**C**

20A05201P	LAB		0	0	3	1.5
Pre-requisite	Computer basics, basic maths	Semester	I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate basic concepts of C programming language.
CO2	Develop C programs using functions, arrays, structures and pointers.
CO3	Illustrate the concepts Stacks and Queues.
CO4	Design operations on Linked lists.
CO5	Apply various Binary tree traversal techniques.
CO6	Develop searching and sorting methods.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Week l** Write C programs that use both recursive and non-recursive functions To find the factorial of a given integer. To find the GCD (greatest common divisor) of two given integers. To solve Towers of Hanoi problem.
2.	**Week 2** a. Write a C program to find both the largest and smallest number in a list of integers. b. Write a C program that uses functions to perform the following: i. Addition of Two Matrices ii. Multiplication of Two Matrices
3.	**Week 3** Write a C program that uses functions to perform the following operations: i. To insert a sub-string in to a given main string from a given position. ii. To delete n characters from a given position in a given string.
4.	**Week 4** a) Write a C program that displays the position or index in the string S where the string Tbegins, or – 1 if S doesn‘t contain T. b) Write a C program to count the lines, words and characters in a given text.
5.	**Week 5** a) Write a C Program to perform various arithmetic operations on pointer variables. b) Write a C Program to demonstrate the following parameter passing mechanisms: i. call-by-value ii. call-by-reference
6.	**Week 6** Write a C program that uses functions to perform the following operations: i. Reading a complex number ii. Writing a complex number

	iii. Addition of two complex numbers iv. Multiplication of two complex numbers (Note: represent complex number using a structure.)
7.	**Week 7** Write C programs that implement stack (its operations) using i) Arrays ii) Pointers
8.	**Week 8** Write C programs that implement Queue (its operations) using i) Arrays ii) Pointers
9.	**Week 9** Write a C program that uses Stack operations to perform the following: i) Converting infix expression into postfix expression ii) Evaluating the postfix expression
10.	**Week 10** Write a C program that uses functions to perform the following operations on singly linked list. (i)Creation ii) Insertion iii) Deletion iv) Traversal
11.	**Week 11** Write a C program that uses functions to perform the following operations on Doubly linkedlist. i) Creation ii) Insertion iii) Deletion iv) Traversal
12.	**Week 12** Write a C program that uses functions to perform the following operations on circular linkedlist. i) Creation ii) Insertion iii) Deletion iv) Traversal
13.	**Week 13** Write a C program that uses functions to perform the following:) Creating a Binary Tree of integers Traversing the above binary tree in preorder, inorder and postorder.
14.	**Week 14** Write C programs that use both recursive and non-recursive functions to perform the followingsearching operations for a key value in a given list of integers: Linear search Binary search
15.	**Week 15** Write a C program that implements the following sorting methods to sort a given list of integers inascending order Bubble sort Selection sort Insertion sort

Course Code	**BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB**		**L**	**T**	**P**	**C**
20A02101P			**0**	**0**	**3**	**1.5**
Pre-requisite	**Basic Physics, basic maths**	**Semester**	**I**			

Course Outcomes:

At the end of the course, students will have the ability to:

Part A: Electrical Engineering Lab	
CO1	Understand Kirchoff's Laws & Superposition theorem.
CO2	Analyze the various characteristics on DC Machines by conducting various tests.
CO3	Analyze I – V Characteristics of PV Cell
CO4	Apply the knowledge to perform various tests on 1-phase transformer
Part B: Electronics Engineering Lab	
CO1	Learn the characteristics of basic electronic devices like PN junction diode, Zener diode &BJT.
CO2	Construct the given circuit in the lab
CO3	Analyze the application of diode as rectifiers, clippers and clampers and other circuits.
CO4	Design simple electronic circuits and verify its functioning.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
Part A: Electrical Engineering Lab	
1.	Verification of Superposition Theorem.
2.	Magnetization characteristics of a DC Shunt Generator.
3.	Speed control of DC Shunt Motor.
4.	OC & SC test of 1 – Phase Transformer.
5.	Load test on 1-Phase Transformer.
6.	I – V Characteristics of Solar PV cell
7.	Brake test on DC Shunt Motor.
Part B: Electronics Engineering Lab	
1.	PN Junction diode characteristics A) Forward bias B) Reverse bias.
2.	Zener diode characteristics and Zener as voltage Regulator.
3.	Full Wave Rectifier with & without filter.
4.	Wave Shaping Circuits. (Clippers & Clampers)
5.	Input & Output characteristics of Transistor in CB / CE configuration.
6.	Frequency response of CE amplifier.
7.	Inverting and Non-inverting amplifiers using Op-AMPs.
8.	Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.
9.	Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs.

UNIT – I 8 Hrs

Multidisciplinary Nature Of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide

problems, water logging, salinity, case studies. – Energy resources:

UNIT – II 12 Hrs

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity And Its Conservation : Introduction 0 Definition: genetic, species and ecosystem diversity
– Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III 8 Hrs

Environmental Pollution: Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV 10 Hrs

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V 8 Hrs

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain.– Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Semester-IV							
S. No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	

1.	20A54402	Numerical Methods &Probability Theory	BS	3	0	0	3
2.	20A03401T	Applied Thermodynamics	PC	3	0	0	3
3.	20A03402	Kinematics of Machinery	PC	3	0	0	3
4.	20A03403T	Manufacturing Technology	PC	3	0	0	3
5.	20A52301 20A52302 20A52303	**Humanities Elective- I** Managerial Economics & Financial Analysis Organizational Behavior Business Environment	HS	3	0	0	3
6.	20A03401P	Applied Thermodynamics Lab	PC	0	0	3	1.5
7.	20A03403P	Manufacturing Technology Lab	PC	0	0	3	1.5
8.	20A03404	Computer Aided Machine Drawing	PC	0	0	3	1.5
9.	20A52401	**Skill oriented course – II** Soft skills	SC	1	0	2	2
10.	20A99401	**Mandatory noncredit course – III** Design Thinking for Innovation	MC	2	1	0	0
11.	20A99301	NSS/NCC/NSO Activities	-	0	0	2	0
			Total				**21.5**
Community Service Internship/Project (Mandatory) for 6 weeks duration during summer vacation							

Course Code	**Differential Equations and Vector Calculus**		**L**	**T**	**P**	**C**
20A54201			**3**	**0**	**0**	**3**
Pre-requisite	**Basic maths**	**Semester**	**II**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Solve the differential equations related to various engineering fields
CO2	Identify solution methods for partial differential equations that model physical processes
CO3	Interpret the physical meaning of different operators such as gradient, curl and divergence
CO4	Estimate the work done against a field, circulation and flux using vector calculus

UNIT – I 9 Hrs

Linear differential equations of higher order (Constant Coefficients)

Definitions, homogenous and non-homogenous, complimentaryfunction, generalsolution, particular integral,Wronskean, method of variation of parameters.Simultaneous linear equations, Applications to L-C-R Circuit problems and Mass spring system.

UNIT – II 9 Hrs

Partial Differential Equations

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order equations using Lagrange's method.

UNIT – III 9 Hrs

Applications of Partial Differential Equations

Classification of PDE, method of separation of variables for second order equations. Applications of Partial Differential Equations: One dimensional Wave equation, One dimensional Heat equation.

UNIT – IV 8 Hrs

Vector differentiation

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT – V 9 Hrs

Vector integration

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

Course Code	Engineering Physics		L	T	P	C
20A56101T			3	0	0	3
Pre-requisite	Basic physics and basic maths	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Study the different realms of physics and their applications in both scientific and technological systems through physical optics.
CO2	Identify the wave properties of light and the interaction of energy with the matter.
CO3	Understands the response of dielectric and magnetic materials to the applied electricand magnetic fields.
CO4	Elucidates the importance of nano materials along with their engineering applications.
CO5	Explain the basic concepts of acoustics and ultrasonics.
CO6	Apply the concept of NDT to material testing.
CO7	Study the important properties of crystals like the presence of long-range order, periodicity and structure determination using X-ray diffraction technique.
CO8	Asses the electromagnetic wave propagation and its power in different media.

UNIT – I 9 Hrs

Wave Optics

Interference- Principle of superposition – Interference of light – Conditions for sustained interference, Interference in thin films (Reflection Geometry) – Colors in thin films – Newton's Rings-Determination of wavelength and refractive index.

Diffraction- Introduction – Fresnel and Fraunhofer diffraction – Fraunhofer diffraction due to singleslit, double slit and N-slits (qualitative) – Grating spectrum.

Polarization- Introduction – Types of polarization – Polarization by reflection, refraction and doublerefraction – Nicol's Prism – Half wave and Quarter wave plates with applications.

UNIT – II 9 Hrs

Lasers and Fiber optics

Lasers- Introduction – Characteristics of laser – Spontaneous and Stimulated emission of radiation – Einstein's coefficients – Population inversion – Lasing action – Pumping mechanisms – Nd-YAG laser – He-Ne laser – Applications of lasers.

Fiber optics- Introduction – Principle of optical fiber – Acceptance Angle – Numerical Aperture – Classification of optical fibers based on refractive index profile and modes – Propagation of electromagnetic wave through optical fibers – Propagation Losses (Qualitative) – Applications.

UNIT – III 9 Hrs

Engineering Materials

Dielectric Materials- Introduction – Dielectric polarization – Dielectric polarizability, Susceptibility and Dielectric constant – Types of polarizations: Electronic, Ionic and Orientation polarization (Qualitative) – Lorentz internal field – Clausius-Mossotti equation.

Magnetic Materials- Introduction – Magnetic dipole moment – Magnetization – Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism (Qualitative) – Hysteresis – Soft and Hard magnetic materials.

Nanomaterials- Introduction – Surface area and quantum confinement – Physical properties: electrical and magnetic properties – Synthesis of nanomaterials: Top-down: Ball Milling – Bottom-up: Chemical Vapour Deposition – Applications of nanomaterials.

UNIT – IV 8 Hrs

Acoustics and Ultrasonics

Acoustics- Introduction – Requirements of acoustically good hall – Reverberation – Reverberation time – Sabine's formula (Derivation using growth and decay method) – Absorption coefficient and its determination – Factors affecting acoustics of buildings and their remedies.

Ultrasonics- Introduction – Properties – Production by magnetostriction and piezoelectric methods – Detection – Acoustic grating – Non Destructive Testing – Pulse echo system through transmission and reflection modes – Applications.

UNIT – V 9 Hrs

Crystallography and X-ray diffraction

Crystallography- Space lattice, Basis, unit cell and lattice parameters – Bravais Lattice – Crystal systems – Packing fraction – Coordination number – Packing fraction of SC, BCC & FCC – Miller indices – Separation between successive (hkl) planes.

Ray Diffraction- Bragg's law – Bragg's X-ray diffractometer – Crystal structure determination by Powder method.

Course Code	COMMUNICATIVE ENGLISH		L	T	P	C
20A52101T			3	0	0	3
Pre-requisite	English grammar	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Retrieve the knowledge of basic grammatical concepts
CO2	Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English
CO3	Apply grammatical structures to formulate sentences and correct word forms
CO4	Analyze discourse markers to speak clearly on a specific topic in informal discussions
CO5	Evaluate reading/listening texts and to write summaries based on global comprehensionof these texts.
CO6	Create a coherent paragraph interpreting a figure/graph/chart/table

UNIT – I 9 Hrs

Lesson: On the Conduct of Life: William Hazlitt

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions. **Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Reading for Writing: Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.

Grammar and Vocabulary: Parts of Speech, Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh- questions; word order in sentences.

UNIT – II 9 Hrs

Lesson: The Brook: Alfred Tennyson

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structured talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.

Grammar and Vocabulary: Cohesive devices - linkers, sign posts and transition signals; use of articles and zero article; prepositions.

UNIT – III 9 Hrs

Lesson: The Death Trap: Saki

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Paragraph Writing

Grammar and Vocabulary: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purpose

UNIT – IV 8 Hrs

Lesson: Innovation: Muhammad Yunus

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.

Writing: Letter Writing: Official Letters/Report Writing

Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; Voice - Active & Passive Voice

UNIT – V 9 Hrs

Lesson: Politics and the English Language: George Orwell

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension. Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Reading: Reading for comprehension. Writing: Writing structured essays on specific topics using suitable claims and evidences. Grammar and Vocabulary: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Course Code	MATERIAL SCIENCE & ENGINEERING		L	T	P	C
20A03201T			3	0	0	3
Pre-requisite	Basic Physics and Chemistry	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Explain the principles of binary phases.
CO2	Select steels and cast irons for a given application.
CO3	Apply heat treatment to different applications.
CO4	Utilize nonferrous metals and alloys in engineering.
CO5	Choose composites for various applications.
CO6	Assess the properties of nano-scale materials and their applications.
CO7	Differentiate between hardening of ferrous and non-ferrous alloys.

UNIT – I 9 Hrs

Structure of Metals: Crystal Structures: Unit cells, Metallic crystal structures, Imperfection in solids: Point, Line, interstitial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions-Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron-Iron-carbide diagram and microstructural aspectsof ferrite, cementite, austenite, ledeburite, and cast iron.

UNIT – II 9 Hrs

Steels:

Plain carbon steels, use and limitations of plain carbon steels. AISI& BIS classification of steels. Classification of alloys steels. Microstructure, properties and applications of alloy steels-stainlesssteels and tool steels.

Cast irons:

Microstructure, properties and applications of white cast iron, malleable cast iron, grey cast iron,nodular cast iron and alloy cast irons.

UNIT – III 9 Hrs

Heat Treatment of Steels: Annealing, tempering, normalizing and hardening, isothermal transformation diagrams for Fe-Fe_3C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening - carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, and vacuum and plasma hardening

UNIT – IV 8 Hrs

Non-ferrous Metals and Alloys: Microstructure, properties and applications of copper, aluminium, titanium, nickel and their alloys. Study of Al-Cu phase diagram.

UNIT – V 9 Hrs

Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers and composites. Introduction to super alloys and nanomaterials.

Course Code	ENGINEERING DRAWING	L	T	P	C
20A03101T		1	0	0/2	2

Pre-requisite	Basic maths	Semester	II

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Draw various curves applied in engineering.
CO2	Show projections of solids and sections graphically.
CO3	Draw the development of surfaces of solids.

UNIT – I 9 Hrs

Introduction to Engineering Drawing: Principles of Engineering Drawing and its significance-Conventions in drawing-lettering - BIS conventions.

a) Conic sections including the rectangular hyperbola- general method only,

b) Cycloid, epicycloids and hypocycloid c) Involutes

UNIT – II 9 Hrs

Projection of points, lines and planes: Projection of points in any quadrant, lines inclined to one or bothplanes, finding true lengths, angle made by line. Projections of regular plane surfaces.

UNIT – III 9 Hrs

Projections of solids: Projections of regular solids inclined to one or both planes by rotational or auxiliary views method.

UNIT – IV 8 Hrs

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder,pyramid and cone. True shapes of the sections.

UNIT – V 9 Hrs

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder,pyramid, cone and their sectional parts.

Course Code	ENGINEERING GRAPHICS LAB		L	T	P	C
20A03101P			0	0	2	1
Pre-requisite	Basic maths	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Use computers as a drafting tool.
CO2	Draw isometric and orthographic drawings using CAD packages.

S. No	Computer Aided Drafting:
1.	**Introduction to AutoCAD:** Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions. Dimensioning principles and conventional representations.
2.	**Orthographic Projections:** Systems of projections, conventions and application to orthographicprojections - simple objects.
3.	**Isometric Projections:** Principles of isometric projection- Isometric scale; Isometric views:lines, planes, simple solids.

Course Code	COMMUNICATIVE ENGLISH LAB		L	T	P	C
20A52101P			0	0	3	1.5
Pre-requisite	English Grammar	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Listening and repeating the sounds of English Language
CO2	Understand the different aspects of the English language
CO3	Proficiency with emphasis on LSRW skills
CO4	Apply communication skills through various language learning activities
CO5	Analyze the English speech sounds, stress, rhythm, intonation and syllable
CO6	Division for better listening and speaking comprehension.
CO7	Evaluate and exhibit acceptable etiquette essential in social and professional settings
CO8	Create awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Phonetics
2.	Reading comprehension
3.	Describing objects/places/persons
4.	Role Play or Conversational Practice
5.	JAM
6.	Etiquettes of Telephonic Communication
7.	Information Transfer
8.	Note Making and Note Taking
9.	E-mail Writing
10.	Group Discussions-1
11.	Resume Writing
12.	Debates
13.	Oral Presentations
14.	Poster Presentation
15.	Interviews Skills-1

Course Code	ENGINEERING PHYSICS LAB		L	T	P	C
20A56101P			0	0	3	1.5
Pre-requisite	Physics	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	operate various optical instruments
CO2	estimate wavelength of laser and particles size using laser
CO3	evaluate the acceptance angle of an optical fiber and numerical aperture
CO4	estimate the susceptibility and related magnetic parameters of magnetic materials
CO5	plot the intensity of the magnetic field of circular coil carrying current with

	distance
CO6	determine magnetic susceptibility of the material and its losses by B-H curve
CO7	apply the concepts of ultrasonics by acoustic grating

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Determine the thickness of the wire using wedge shape method
2.	Determination of the radius of curvature of the lens by Newton's ring method
3.	Determination of wavelength by plane diffraction grating method
4.	Determination of dispersive power of prism.
5.	Determination of wavelength of LASER light using diffraction grating.
6.	Determination of particle size using LASER.
7.	To determine the numerical aperture of a given optical fiber and hence to find its acceptanceangle
8.	Determination of dielectric constant by charging and discharging method.
9.	Magnetic field along the axis of a circular coil carrying current –Stewart Gee's method.
10.	Measurement of magnetic susceptibility by Gouy's method
11.	Study the variation of B versus H by magnetizing the magnetic material (B-H curve)
12.	Determination of ultrasonic velocity in liquid (Acoustic grating)
13.	Rigidity modulus of material of a wire-dynamic method (Torsional pendulum)
14.	Sonometer: Verification of the three laws of stretched strings
15.	Determination of spring constant of springs using Coupled Oscillator

Course Code	**MATERIAL SCIENCE & ENGINEERING LAB**		**L**	**T**	**P**	**C**
20A03201P			**0**	**0**	**3**	**1.5**
Pre-requisite	**Basics Physics and Chemistry**	**Semester**	**II**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Differentiate various microstructures of ferrous and non-ferrous metals and alloys.
CO2	Visualize grains and grain boundaries.
CO3	Importance of hardening of steels.
CO4	Evaluate hardness of treated and untreated steels.
CO5	Differentiate hardness of super alloys, ceramics and polymeric materials

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Metallography sample preparation
2.	Microstructure of pure metals – Iron, copper and aluminum as per ASTM standards
3.	Microstructure of low carbon steel, mild steel and high carbon microstructure of cast irons.
4.	Microstructure of non-ferrous alloys – aluminum, copper, titanium, nickel and their alloys.
5.	Hardenability of steels by Jominy End Quench Test.

6.	Microstructure of heat treated steels.
7.	Hardness of various untreated and treated steels.
8.	Microstructure of ceramics, polymeric materials.
9.	Microstructure of super alloy and nano-materials.
10.	Hardness of ceramics, super alloys, nano-materials and polymeric materials (one sample oneach)

Course Code	UNIVERSAL HUMAN VALUES		L	T	P	C
20A52201			3	0	0	0
Pre-requisite	Social Sciences	Semester	II			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Students are expected to become more aware of themselves, and their surroundings(family, society, nature)
CO2	They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
CO3	They would have better critical ability.
CO4	They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO5	It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

UNIT – I 9 Hrs

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the currentscenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels

UNIT – II 9 Hrs

Understanding Harmony in the Human Being - Harmony in Myself!

- Understanding human being as a co-existence of the sentient 'I' and the material

'Body'

- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

UNIT – III 9 Hrs

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

UNIT – IV 8 Hrs

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all-pervasivespace
- Holistic perception of harmony at all levels of existence.

UNIT – V 9 Hrs

Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
- Sum up.

Course Code	Complex variables, Transforms & Partial DifferentialEquations		L	T	P	C
20A54303			3	0	0	3
Pre-requisite	Functions, Differentiations and Integration	Semester	II I			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understand the analyticity of complex functions and conformal mappings.
CO2	Apply cauchy's integral formula and cauchy's integral theorem to evaluate improperintegrals along contours.
CO3	Understand the usage of laplace transforms.
CO4	Evaluate the fourier series expansion of periodic functions.
CO5	Formulate/solve/classify the solutions of partial differential equations and also find thesolution of one-dimensional wave equation and heat equation.

UNIT – I 9 Hrs

Complex Variable – Differentiation:

Introduction to functions of complex variable-concept of Limit & continuity- Differentiation, Cauchy-Riemann equations, analytic functions (exponential, trigonometric, logarithm), harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method- Conformal mappings-standard transformations (e^z, , kz) Mobius transformations (bilinear) and their properties.

UNIT – II 9 Hrs

Complex Variable – Integration:

Line integral-Contour integration, Cauchy's integral theorem, Cauchy Integral formula, Liouville's theorem (without proof) and Maximum-Modulus theorem (without proof);power series expansions: Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (around unit circle, semi circle with f(z) not having poles on real axis).

UNIT – III 9 Hrs

Laplace Transforms:

Definition-Laplace transform of standard functions-existence of Laplace Transform – Inverse transform – First shifting Theorem, Transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function. Differentiation and integration of transform – solving Initial value problems to ordinary differential equations with constant coefficients using Laplace transforms.

UNIT – IV 8 Hrs

Fourier series:

Determination of Fourier coefficients (Euler's) – Dirichlet conditions for the existence of Fourier series – functions having discontinuity-Fourier series of Even and odd functions – Fourier series in an arbitrary interval – Half-range Fourier sine and cosine expansions- typical wave forms -

Parseval's formula- Complex form of Fourier series.

UNIT – V 9 Hrs

Partial Differential Equations & Applications:

Solution of second order PDEs by Method of separation of variables – Solutions of one dimensional wave equation, one dimensional heat equation under initial and boundary conditions. Steady statetwo dimensional heat equations (Laplace equations).

Course Code	Fluid Mechanics and Hydraulic Machines (Common to Civil & Mechanical)		L	T	P	C
20A01302T			3	0	0	3
Pre-requisite	Physics, Chemistry	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Possess a sound knowledge of fundamental properties of fluids and fluid continuum and types of fluid flow.
CO2	Compute and solve problems on hydrostatics, including practical applications
CO3	Apply principles of mathematics to represent kinematic concepts related to fluid flow
CO4	Apply fundamental laws of fluid mechanics and the Bernoulli's principle for practical applications.
CO5	Compute the discharge through pipes can critically analyze the performance of pumps and turbines

UNIT – I 9 Hrs

Introduction to Fluid Statics:

Distinction between a fluid and a solid - characteristics of fluids - Fluid Pressure: Pressure at a point, Pascal's law, and pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U Tube Differential Manometer. Pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

UNIT – II 9 Hrs

Fluid kinematics and Dynamics:

Classification of fluid flow - Stream line, path line, streak line and stream tube; stream function, velocity potential function. One, two and three - dimensional continuity equations in Cartesian coordinates.

Fluid Dynamics: Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation: Venturimeter, orifice meter and Pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number

UNIT – III 9 Hrs

Analysis Of Pipe Flow:

Energy losses in pipelines; Darcy – Weisbach equation; Minor losses in pipelines; Hydraulic Grade Line and Total Energy Line; Concept of equivalent length – Pipes in Parallel and Series. Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity. Reynolds experiment, Transition from laminar to turbulent flow. Resistance to flow of fluid in smooth and rough pipes-Moody's diagram – Introduction to boundary layer theory.

UNIT – IV 8 Hrs

Flow in Open Channels:

Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section. Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Computation of Uniform flow.Specific energy, critical flow, discharge curve, Specific force, Specific depth, and Critical depth. Measurement of Discharge and Velocity – Broad Crested Weir. Gradually Varied FlowDynamic Equation of Gradually Varied Flow. Hydraulic Jump and classification - Elements and characteristics- Energy dissipation.

UNIT – V 9 Hrs

Hydraulic Machines:
Impact of Jets- Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes - velocity triangles at inlet and outlet - Work done and efficiency - Hydraulic Turbines: Classification of turbines; pelton wheel and its design. Francis turbine and its design - efficiency - Draft tube: theory
- characteristic curves of hydraulic turbines - Cavitation - Working principles of a centrifugal pump, work done by impeller; heads, losses and efficiencies; minimum starting speed; Priming; specific speed; limitation of suction lift, net positive suction head (NPSH); Performance and characteristic curves; Cavitation effects; Multistage centrifugal pumps; troubles and remedies – Introduction to Reciprocating Pump.

Course Code	Manufacturing Processes		L	T	P	C
20A03301T			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:
At the end of the course, students will have the ability to:

CO1	Analyze and access the use of casting processes in manufacturing and understand the working of various casting processes
CO2	Understand the basics of metal cutting and working of different types of machine tools.
CO3	Explain the conventional and advanced metal forming processes and composite fabrication.
CO4	Analyze and access the importance of welding processes in manufacturing and apply knowledge to select appropriate welding process based on the type of industrial application.

UNIT – I 8 Hrs
Casting Processes:
Introduction: Importance and selection of manufacturing processes. Introduction to casting process, process steps; pattern and design of gating system; Solidification of casting: Concept, solidification of pure metal and alloy; Special casting processes: Shell casting, investment casting, die casting, centrifugal casting, casting defects and remedies.
UNIT – II 8 Hrs
Metal Forming & Forging:
Introduction, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming; Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements; Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.
Principles of forging, tools and dies. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping.
UNIT – III 8 Hrs
Metal Joining Processes:
Classification of welding processes, types of welds and welded joints and V-I characteristics, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. Applications, advantages and disadvantages of the above processes, Plasma Arc welding, Laser Beam Welding, Electron Beam Welding and Friction Stir Welding. Heat affected zones in welding; soldering and brazing: Types and their applications, Welding defects: causes and remedies.
UNIT – IV 8 Hrs
Plastic Processing, Ceramics and Powder Metallurgy:
Plastics: Types, properties and their applications, processing of plastics, extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding, and blow molding

Ceramics: Classification of ceramic materials, properties and their application, ceramic powder preparation; Processing of ceramic parts: Pressing, casting, sintering; Secondary processing of ceramics: Coatings, finishing.
Powder Metallurgy: Principle, manufacture of powders, steps involved.
UNIT – V 10 Hrs
Unconventional Machining Processes:
principle and processes parameters of Electrical discharge machining (EDM), electro-chemical machining (ECM), Laser beam machining (LBM), plasma arc machining (PAM), electron beam machining, Abrasive jet machining (AJM), water jet machining (WJM), and ultrasonic machining(UM)

Course Code	Thermodynamics		L	T	P	C
20A03302			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:
At the end of the course, students will have the ability to:

CO1	Use thermodynamic terminology correctly.
CO2	Explain fundamental thermodynamic properties.
CO3	Derive and discuss the first and second laws of thermodynamics.
CO4	Solve problems using the properties and relationships of thermodynamic fluids. Analyse basic thermodynamic cycles.
CO5	Students must have understanding of thermodynamic fundamentals before studying their application in applied thermodynamics.
CO6	The understanding of thermodynamic properties and processes will assist students in other related coursework.

UNIT – I 10 Hrs
First law of Thermodynamics:
Introduction: Basic Concepts: Macroscopic and microscopic viewpoints, definitions of thermodynamic terms, quasi – static process, point and path function, forms of energy, ideal gas and real gas, Zeroth law of thermodynamics and Temperature measurement.
Joule's experiment - first law of thermodynamics, corollaries-perpetual motion machines of first kind, first law applied to non-flow and flow process- limitations of first law of thermodynamics**.**
UNIT – II 8 Hrs
Second Law of Thermodynamics:
Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - perpetual motion machines of second kind - reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency.
UNIT – III 8 Hrs
Entropy, Availability and Irreversibility:
Clausius inequality - Concept of Entropy- entropy equation for different processes and systems. Definition of exergy and anergy, expressions for availability and irreversibility. Availability in steadyflow, non-flow processes and irreversibility.
Maxwell relations, TdS equations difference in heat capacities, ratio of heat capacities.
UNIT – IV 8 Hrs
Properties of Steam and use of Steam Tables:
Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry. Energy equation, Joule Thompson coefficient Clausius - Clapeyron equation.
UNIT – V 8 Hrs

Air Standard Cycles:
Otto, Diesel and dual cycles, P-V and T -S diagrams - description and efficiencies, mean effective pressures. Brayton Cycle - Comparison of Otto, Diesel and dual cycles, Comparison of Brayton and Otto Cycles.

Course Code	Mechanics of Materials		L	T	P	C
20A01305T			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:
At the end of the course, students will have the ability to:

CO1	Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
CO2	Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
CO3	Apply basic equation of simple torsion in designing of shafts and helical spring
CO4	Calculate the slope and deflection in beams using different methods. Analyze and design thin and thick shells for the applied internal and external pressures.

UNIT – I 8 Hrs
Analysis of stress and strain:
Types of external loads - self weight - internal stresses - normal and shear stresses - strain - Hooke's law - Poisson's ratio - relationship between elastic constants - stress strain diagrams working stress - elongation of bars of constant and varying sections - Stress on inclined planes for axial and biaxial stress fields - principal stresses - Mohr's circle of stress - principal strains - strain rosette – principal stress/strain problem as an Eigen value problem.

UNIT – II 8 Hrs
Bending moment and shear force:
Different types of beams - shear force and bending moment diagrams for simply supported, overhanging and cantilever beams - relationship connecting intensity of loading, shearing force and bending moment - shear force and bending moment diagrams for statically determinate plane frames.

UNIT – III 8 Hrs
Torsion and Springs:
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT – IV 8 Hrs
Thin Cylinders, Spheres and Thick Cylinders :
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame"s theory – Application of theories of failure.

UNIT – V 10 Hrs
Bending of curved bars & Unsymmetrical Bending:
Stresses in bars of small initial curvature, Winkler-Bach theory, Stresses in bars of large initialcurvature, Deflection of Crane hooks, Chain links, circular rings, and stresses in circular rings. Introduction to unsymmetrical bending, Stresses and deflection in unsymmetrical bending, Shearcenter for angle, Channel and I-sections.

Course Code	FLUID MECHANICS AND HYDRAULIC MACHINES LAB (Common to Civil & Mechanical)		L	T	P	C
20A01302P			0	0	3	1.5
Pre-requisite	NIL	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Possess a sound knowledge of fundamental properties of fluids and fluid continuum and types of fluid flow.
CO2	Compute and solve problems on hydrostatics, including practical applications
CO3	Apply principles of mathematics to represent kinematic concepts related to fluid flow
CO4	Apply fundamental laws of fluid mechanics and the Bernoulli's principle for practical applications.
CO5	Compute the discharge through pipes can critically analyze the performance of pumps and turbines

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Verification of Bernoulli's equation.
2.	Calibration of Venturi meter.
3.	Calibration of Orifice meter
4.	Determination of Coefficient of discharge for a small orifice by constant head method.
5.	Determination of Coefficient of discharge for a small orifice by variable head method.
6.	Determination of Coefficient of discharge for an external mouth piece by Constant headmethod.
7.	Determination of Coefficient of discharge for an external mouth piece by variable headmethod.
8.	Calibration of contracted Rectangular Notch.
9.	Calibration of contracted Triangular Notch. Determination of friction factor.
10.	Determination of loss of head in a sudden contraction.
11.	Determination of loss of head in a sudden Expansion.
12.	Performance test on Impulse turbines.
13.	Performance test on reaction turbines (Francis and Kaplan Turbines).
14.	Impact of jet.
15.	Performance test on centrifugal pumps, determination of operating point and efficiency.

Course Code	Manufacturing Processes Lab		L	T	P	C
20A03301P			0	0	3	1.5
Pre-requisite	NIL	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understanding the properties of moulding sands and pattern making.
CO2	Fabricate joints using gas welding and arc welding.
CO3	Evaluate the quality of welded joints.
CO4	Basic idea of press working tools and performs moulding studies on plastics.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**METAL CASTING** a) Gating Design and pouring time and solidification time calculations. b) Sand Properties Testing – Exercise for Strength and Permeability. c) Molding, Melting and Casting for ferrous/ non ferrous materials.
2.	**WELDING**

	a) TIG Welding. b) MIG Welding. c) Friction stir welding. d) Any other Special Welding Processes.
3.	**MECHANICAL PRESS WORKING** a) Press Tool: Blanking and Piercing operation with Simple, Compound and Combination dies. b) Closed die forging, Deep Drawing and Extrusion operations.
4.	**UN CONVENTIONAL MANUFACTUNRING PROCESSES** a) Electro Discharge Machining (EDM) / Wire cut EDM. b) Plasma arc cutting / Abrasive jet machining (AJM). c) Additive manufacturing with reverse engineering.

Course Code	**Mechanics of Materials Lab**		**L**	**T**	**P**	**C**
20A01305P			**0**	**0**	**3**	**1.5**
Pre-requisite	**NIL**	**Semester**	**III**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Ability to perform different destructive testing
CO2	Ability to characteristic materials

LABORATORY EXPERIMENT LIST

S. No	**Title of the Experiments**
1.	Tension test.
2.	Bending test on (Steel/Wood) Cantilever beam.
3.	Bending test on simply supported beam.
4.	Torsion test.
5.	Vickers Hardness Test
6.	Rockwell Hardness Test
7.	Brinell Hardness Test
8.	Compression test on Open coiled springs
9.	Tension test on Closely coiled springs
10.	Compression test on wood/ concrete
11.	Izod Impact test on metals
12.	Charpy Impact test on metals
13.	Shear test on metals
14.	Direct Shear Test on Timber Specimen
15.	Use of electrical resistance strain gauges.
16.	Continuous beam – deflection test

Note: Any 12 of the above equipments

Course Code	**Application Development with Python**		**L**	**T**	**P**	**C**
20A05305			**1**	**0**	**2**	**2**
Pre-requisite	**NIL**	**Semester**	**III**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Identify the issues in software requirements specification and enable to write SRS documentsfor software development problems
CO2	Explore the use of Object oriented concepts to solve Real-life problems
CO3	Design database for any real-world problem

CO4	Solve mathematical problems using Python programming language

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
Module 1.	**Basic concepts in software engineering and software project management** Basic concepts: abstraction versus decomposition, the evolution of software engineering techniques, Software development life cycle Software project management: project planning and project scheduling Task: 1. Identifying the Requirements from Problem Statements
Module 2.	**Basic Concepts of Databases** Database systems applications, Purpose of Database Systems, view of Data, Database Languages, Relational Databases, Data Definition Language(DDL) Statements: (Create table, Alter table, Drop table), Data Manipulation Language(DML) Statements Task: 1. Implement Data Definition Language(DDL) Statements: (Create table, Alter table, Drop table) 2. Implement Data Manipulation Language(DML) Statements
Module 3.	**Python Programming:** **Introduction to Python:** Features of Python, Data types, Operators, Input and output, ControlStatements, Looping statements **Python Data Structures:** Lists, Dictionaries, Tuples. **Strings:** Creating strings and basic operations on strings, string testing methods. **Functions:** Defining a function- Calling a function- Types of functions- Function Arguments-Anonymous functions- Global and local variables **OOPS Concepts;** Classes and objects- Attributes- Inheritance- Overloading- Overriding- Data hiding **Modules and Packages:** Standard modules-Importing own module as well as external modules Understanding Packages Powerful Lamda function in python Programming using functions, modules and external packages **Working with Data in Python:** Printing on screen- Reading data from keyboard- Opening and closingfile- Reading and writing files- Functions-Loading Data with Pandas-Numpy Tasks: **1. OPERATORS** a) Read a list of numbers and write a program to check whether a particular element is present or not using membership operators. b) Read your name and age and write a program to display the year in which you will turn 100 years old. c) Read radius and height of a cone and write a program to find the volume of a cone. d) Write a program to compute distance between two points taking input from the user (Hint: use Pythagorean theorem) **2. CONTROL STRUCTURES** a) Read your email id and write a program to display the no of vowels, consonants, digits and white spaces in it using if…elif…else statement. b) Write a program to create and display a dictionary by storing the antonyms of words. Find the antonym of a particular word given by the user from the dictionary using while loop. c) Write a Program to find the sum of a Series 1/1! + 2/2! + 3/3! + 4/4! +……. + n/n!. (Input :n = 5, Output : 2.70833) d) In number theory, an abundant number or excessive number is a number for

which the sum of its proper divisors is greater than the number itself. Write a program to find out, if the given number is abundant. (Input: 12, Sum of divisors of 12 = 1 + 2 + 3 + 4 + 6 = 16, sum of divisors 16 > original number 12)

3. LIST

a) Read a list of numbers and print the numbers divisible by x but not by y (Assume x = 4 and y = 5).
b) Read a list of numbers and print the sum of odd integers and even integers from the list.(Ex: [23, 10, 15, 14, 63], odd numbers sum = 101, even numbers sum = 24)
c) Read a list of numbers and print numbers present in odd index position. (Ex: [10, 25, 30, 47, 56, 84, and 96], the numbers in odd index position: 25 47 84).
d) d. Read a list of numbers and remove the duplicate numbers from it. (Ex: Enter a list with duplicate elements: 10 20 40 10 50 30 20 10 80, The unique list is: [10, 20, 30, 40, 50, 80])

4. TUPLE

a) Given a list of tuples. Write a program to find tuples which have all elements divisible by K from a list of tuples. test_list = [(6, 24, 12), (60, 12, 6), (12, 18, 21)], K = 6, Output : [(6, 24, 12), (60, 12, 6)]
b) Given a list of tuples. Write a program to filter all uppercase characters tuples from given list of tuples. (Input: test_list = [(“GFG”, “IS”, “BEST”), (“GFg”, “AVERAGE”), (“GfG”,), (“Gfg”, “CS”)], Output : [(„GFG“, „IS“, „BEST“)]).
c) Given a tuple and a list as input, write a program to count the occurrences of all items of the list in the tuple. (Input : tuple = ('a', 'a', 'c', 'b', 'd'), list = ['a', 'b'], Output : 3)

5. SET

a) Write a program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x).
b) Write a program to perform union, intersection and difference using Set A and Set B.
c) Write a program to count number of vowels using sets in given string (Input : “Hello World”, Output: No. of vowels : 3)
d) Write a program to form concatenated string by taking uncommon characters from two strings using set concept (Input : S1 = "aacdb", S2 = "gafd", Output : "cbgf").

6. DICTIONARY

a) Write a program to do the following operations:
   i. Create a empty dictionary with dict() method
   ii. Add elements one at a time
   iii. Update existing key“s value
   iv. Access an element using a key and also get() method
   v. Deleting a key value using del() method
b) Write a program to create a dictionary and apply the following methods:
   i. pop() method
   ii. popitem() method
   iii. clear() method
c) Given a dictionary, write a program to find the sum of all items in the dictionary.
d) Write a program to merge two dictionaries using update() method.

7. STRINGS

a) Given a string, write a program to check if the string is symmetrical and

palindrome or not. A string is said to be symmetrical if both the halves of the string are the same and a string is said to be a palindrome string if one half of the string is the reverse of the other half or if a string appears same when read forward or backward.

b) Write a program to read a string and count the number of vowel letters and print all letters except 'e' and's'.

c) Write a program to read a line of text and remove the initial word from given text. (Hint: Use split () method, Input: India is my country. Output : is my country)

d) Write a program to read a string and count how many times each letter appears. (Histogram).

8. USER DEFINED FUNCTIONS

a) A generator is a function that produces a sequence of results instead of a single value. Write a generator function for Fibonacci numbers up to n.

b) Write a function merge_dict(dict1, dict2) to merge two Python dictionaries.

c) Write a fact() function to compute the factorial of a given positive number.

d) Given a list of n elements, write a linear_search() function to search a given element x in a list.

9. BUILT-IN FUNCTIONS

a) Write a program to demonstrate the working of built-in statistical functions mean(), mode(), median() by importing statistics library.

b) Write a program to demonstrate the working of built-in trignometric functions sin(), cos(), tan(), hypot(), degrees(), radians() by importing math module.

c) Write a program to demonstrate the working of built-in Logarithmic and Power functions exp (), log (), log2 (), log10 (), pow() by importing math module.

d) Write a program to demonstrate the working of built-in numeric functions ceil (), floor (), fabs (), factorial (), gcd() by importing math module.

10. CLASS AND OBJECTS

a) Write a program to create a BankAccount class. Your class should support the following methods for

i. Deposit
ii. Withdraw
iii. GetBalanace
iv. PinChange

b) Create a SavingsAccount class that behaves just like a BankAccount, but also has an interest rate and a method that increases the balance by the appropriate amount of interest (Hint:use Inheritance).

c) Write a program to create an employee class and store the employee name, id, age, and salary using the constructor. Display the employee details by invoking employee_info() method and also using dictionary (__dict__).

d) Access modifiers in Python are used to modify the default scope of variables. Write a program to demonstrate the 3 types of access modifiers: public, private and protected.

11. FILE HANDLING

a. Write a program to read a filename from the user, open the file (say firstFile.txt) and then perform

i. the following operations:
ii. Count the sentences in the file.
iii. Count the words in the file.
iv. Count the characters in the file.

b. Create a new file (Hello.txt) and copy the text to other file called target.txt.

	The target.txt file should store only lower case alphabets and display the number of lines copied. c. Write a Python program to store N student's records containing name, roll number and branch. Print the given branch student's details only.

Course Code	ENVIRONMENTAL SCIENCE		L	T	P	C
20A99201	(Common to All Branches of Engineering)		3	0	0	0
Pre-requisite	NIL	Semester	III Sem			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Grasp multidisciplinary nature of environmental studies and various renewable and nonrenewableresources.
CO2	Understand flow and bio-geo- chemical cycles and ecological pyramids.
CO3	Understand various causes of pollution and solid waste management and related preventivemeasures.
CO4	About the rainwater harvesting, watershed management, ozone layer depletion and waste landreclamation.
CO5	Casus of population explosion, value education and welfare programmes.

UNIT – I 8 Hrs

Multidisciplinary Nature Of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT – II 12 Hrs

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

e. Forest ecosystem.
f. Grassland ecosystem
g. Desert ecosystem
h. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity And Its Conservation : Introduction 0 Definition: genetic, species and ecosystem diversity
– Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III 8 Hrs

Environmental Pollution: Definition, Cause, effects and control measures of :

h. Air Pollution.
i. Water pollution
j. Soil pollution
k. Marine pollution
l. Noise pollution
m. Thermal pollution
n. Nuclear hazards

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV 10 Hrs

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V 8 Hrs

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain.– Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Semester-IV							
S. No.	**Course Code**	**Course Name**	**Category**	**Hours per week**			**Credits**
				L	**T**	**P**	
1.	20A54402	Numerical Methods &Probability Theory	BS	3	0	0	3
2.	20A03401T	Applied Thermodynamics	PC	3	0	0	3
3.	20A03402	Kinematics of Machinery	PC	3	0	0	3
4.	20A03403T	Manufacturing Technology	PC	3	0	0	3
5.	20A52301 20A52302 20A52303	**Humanities Elective- I** Managerial Economics & Financial Analysis Organizational Behavior Business Environment	HS	3	0	0	3
6.	20A03401P	Applied Thermodynamics Lab	PC	0	0	3	1.5
7.	20A03403P	Manufacturing Technology Lab	PC	0	0	3	1.5
8.	20A03404	Computer Aided Machine Drawing	PC	0	0	3	1.5
9.	20A52401	**Skill oriented course – II** Soft skills	SC	1	0	2	2
10.	20A99401	**Mandatory noncredit course – III** Design Thinking for Innovation	MC	2	1	0	0
11.	20A99301	NSS/NCC/NSO Activities	-	0	0	2	0
			Total				**21.5**

Community Service Internship/Project (Mandatory) for 6 weeks duration during summer vacation

Course Code	Numerical Methods & Probability theory (Common to EEE, MECH)		L	T	P	C
20A54402			3	0	0	3
Pre-requisite	Basic Equations and Basic Probability	Semester	IV			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Apply numerical methods to solve algebraic and transcendental equations
CO2	Derive interpolating polynomials using interpolation formulae
CO3	Solve differential and integral equations numerically
CO4	Apply probability theory to find the chances of happening of events.
CO5	Understand various probability distributions and calculate their statistical constants.

UNIT – I 8 Hrs

Solution of Algebraic & Transcendental Equations:

Introduction-Bisection method-Iterative method-Regula falsi method-Newton Raphson method System of Algebraic equations: Gauss Jordan method-Gauss Siedal method.

UNIT – II 8 Hrs

Interpolation:

Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae.Gauss forward and backward formula, Stirling's formula, Bessel's formula.

UNIT – III 9 Hrs

Numerical Integration & Solution of Initial value problems to Ordinary differential equations:

Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Methodof successive Approximations-Modified Euler's Method-Runge-Kutta Methods.

UNIT – IV 9 Hrs

Probability theory:

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

UNIT – V 9 Hrs

Random variables & Distributions:

Probability distribution - Binomial, Poisson approximation to the binomial distribution and normaldistribution-their properties-Uniform distribution-exponential distribution.

Course Code	Applied Thermodynamics		L	T	P	C
20A03401T			3	0	0	3
Pre-requisite	NIL	Semester	IV			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate the principles of thermal engineering in power producing fields.
CO2	Differentiate among different internal combustion engine designs.
CO3	Recognize and understand reasons for differences among operating characteristics of different engine types and designs.
CO4	Analyze engineering systems needed to set-up and run engines in controlled

	laboratory environments.
CO5	Compare and contrast experimental results with theoretical trends, and to attribute observed discrepancies to either measurement error or modeling limitations.

UNIT – I 10 Hrs

IC Engines:

Working and classification of IC engines, comparison of two stroke and four stroke engines, comparisonof SI and CI Engines.

Testing and Performance of IC Engines: Methods of testing IC Engines, performance analysis of ICEngines.

Combustion in IC Engines: SI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting ignition lag, Flame propagation and knocking. CI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting delay period and knocking.

UNIT – II 8 Hrs

Air compressors

Reciprocating Compressor: Single stage reciprocating compressors, work required, effect of clearance in compressors, volumetric efficiency, multi stage compressor, effect of inter cooling in multi stage compressors, compressor performance.

Rotary Compressor: Working principle of a rolling piston type compressor (fixed vane type), multi vane type compressors, characteristics of rotary vane type compressor, working principle of centrifugal and axial flow compressors.

UNIT – III 8 Hrs

Vapour & Gas Power Cycles:

Vapour power cycle, simple Rankine cycle, mean temp of heat addition, thermodynamic variables effecting efficiency, Rankine cycle – reheating and regeneration.

Simple gas turbine plant, Brayton cycle, closed cycle and open cycle for gas turbines, condition foroptimum pressure ratio, actual cycle. Methods to improve performance: regeneration, intercooling and reheating.

UNIT – IV 8 Hrs

Nozzles & Steam Turbines:

Type of nozzles - gas and steam nozzles. Compressible flow through nozzle- condition for maximumdischarge - Nozzle efficiency - Super saturation.

Steam Turbines - impulse turbine and reaction turbine – compounding of impulse turbines - velocitydiagrams in impulse and reaction turbines, blade efficiency, degree of reaction.

UNIT – V 8 Hrs

Refrigeration & Air-Conditioning:

Refrigeration: Bell-Coleman cycle - vapour compression cycle, sub cooling and super heating-vapourabsorption cycle, properties of common refrigerants.

Principles of Psychrometry and Air Conditioning: Psychometric properties, psychometric processes,summer and winter air conditioning systems.

Course Code	**KINETICS OF MACHINERY**		**L**	**T**	**P**	**C**
20A03402			**3**	**0**	**0**	**3**
Pre-requisite	**NIL**	**Semester**	**IV**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Build up critical thinking and problem-solving capacity of various mechanical engineering problems related to kinematics of machines
CO2	Familiarity with common mechanisms used in machines and everyday life.
CO3	Identify different mechanisms, Inversions of kinematic chains
CO4	Ability to perform analysis of different types of links, position, velocity, acceleration analyses.
CO5	Utilize analytical, mathematical and graphical aspects of kinematics of Machines

	for effectivedesign
CO6	Construct the cam profile for a given motion
CO7	Analyze various gear trains

UNIT – I 8 Hrs

Mechanisms and Machines:

Elements or Links – Classification – Rigid Link, flexible and fluid link. Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained. Mechanisms and machines – classification of mechanisms and machines – kinematic chain – inversion of mechanisms – inversions of quadric cycle chain, single and double slider crank chain. Mobility of mechanisms.

UNIT – II 8 Hrs

Steering & Straight-Line Motion Mechanisms:

Straight Line Motion Mechanisms- Exact and approximate, copied and generated types – Peaucellier, Hart, Scott Russel, Grasshopper, Watt, Tchebicheff and Robert Mechanisms. Pantograph.

Steering Mechanisms: Conditions for correct steering – Davis Steering gear, Ackermanns steering gear. Hooke's Joint (Universal coupling) -Single and double Hooke's joint — applications – Simple problems.

UNIT – III 10 Hrs

Kinematics:

Velocity and Acceleration Diagrams- Velocity and acceleration – Motion of link in machine – Determination of Velocity and acceleration – Graphical method – Application of relative velocity method

– Slider crank mechanism, four bar mechanism. Acceleration diagrams for simple mechanisms, determination of Coriolis component of acceleration, Klein's construction: Analysis of slider crank mechanism for displacement, velocity and acceleration of slider using analytical method.

Instantaneous Centre Method: Instantaneous centre of rotation, centrode and axode – relative motion between two bodies – Three centers in-line theorem – Locating instantaneous canters for simple mechanisms and determination of angular velocity of points and links.

UNIT – IV 10 Hrs

Gears & Gear Trains:

GEARS: Higher pairs, toothed gears – types – law of gearing, condition for constant velocity Ratio for transmission of motion, Forms of tooth- cycloidal and involute profiles. Velocity of sliding – phenomena of interference – Methods to avoid interference - Condition for minimum number of teeth, expressions

for arc of contact and path of contact. Introduction to Helical, Bevel and Worm gears.

GEAR TRAINS:

Introduction –Types of gears – Simple, Compound, Reverted and Epicyclic gear trains, Train value – Methods of finding train value or velocity ratio – Tabular column method for Epicyclic gear trains. Torque in epicyclic gear trains. Differential gear of an automobile – Simple problems.

UNIT – V 8 Hrs

CAMS & Followers

CAMS: Definitions of cam and follower – uses – Types of followers and cams – Terminology. Types of follower motion - Uniform velocity, Simple harmonic motion, Cycloidal, uniform acceleration and retardation, Maximum velocity and maximum acceleration during outward and return strokes. Drawingof cam profiles.

ANALYSIS OF MOTION OF FOLLOWERS: Tangent cam with roller follower – circular arc (Convex) cam with flat faced and roller follower.

Course Code	Manufacturing Technology		L	T	P	C
20A03403T			3	0	0	3
Pre-requisite	NIL	Semester	IV			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate the theory of metal cutting related to lathe, milling machines, drilling machine, grinding machines etc.
CO2	Select cutting tool materials metal cutting and tool geometries for different metal cutting operations.
CO3	Select appropriate machining processes for different processes. Understand machine tool structures and machining economics.
CO4	Identify methods to generate different types of surfaces.
CO5	Explain work-holding requirements.
CO6	Design jigs and fixtures.

UNIT – I 8 Hrs

Material Removal Processes:

Metal Cutting: Single and multi-point cutting tools, orthogonal and oblique cutting, Merchant circle diagram, chip formation, tool wear and tool life, surface finish and integrity, machinability, cutting toolsand materials, cutting fluids.

UNIT – II 12 Hrs

Lathe and Drilling Machines:

Lathe and Lathe Operations: Principles of working, specifications, types of lathes, operations, work and tool holders. Taper turning, thread turning attachments for lathes. Machining time calculations. Turret and capstan lathes - Principle of working -

Drilling Machines: Principles of working, specifications, types, and operations performed - tool holdingdevices - nomenclature of twist drill, Machining time calculations.

UNIT – III 8 Hrs

Boring, Reaming and Taping:

Boring Machines- Principles of working, specifications, types, and operations performed - tool holdingdevices - nomenclature of boring tools, Machining time calculations

Reaming and Reamers: Principles of working, specifications, types, and operations performed – toolholding devices - nomenclature of reamers. Machining time calculations

Taping and Taps: Principles of working, specifications, types, and operations performed - tool holdingdevices - nomenclature of taps.

UNIT – IV 10 Hrs

Milling, Shaping and Abrasive Machining:

Milling operations and Milling machines - Principles of working, specifications, classifications of milling machines, machining operations, types and geometry of milling cutters, methods of indexing, andaccessories to milling machines, machining time calculations.

Shaping, Slotting and planing machines - Principles of working - principal parts, specification, classification, operations performed, machining time calculations

Abrasive Machining: Grinding and grinding machines: Grinding process, types of grinding machines, grinding process parameters, honing, lapping, other finishing processes.

UNIT – V 8 Hrs

Jigs and Fixtures:

Principles of design of Jigs and fixtures and uses, 3-2-1 principle of location and clamping, classification of Jigs & Fixtures, types of clamping and work holding devices, typical examples of jigs and fixtures.

Course Code	MANAGERIAL ECONOMICS AND FINANCIALANALYSIS (Common to All branches of Engineering)		L	T	P	C
20A52301			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Define the concepts related to Managerial Economics, financial accounting and management.
CO2	Understand the fundamentals of Economics viz., Demand, Production, cost, revenue andmarkets.
CO3	Apply the Concept of Production cost and revenues for effective Business decision.
CO4	Analyze how to invest their capital and maximize returns.
CO5	Evaluate the capital budgeting techniques.
CO6	Develop the accounting statements and evaluate the financial performance of business entity.

UNIT – I 8 Hrs

Managerial Economics:

Introduction – Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting-Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

UNIT – II 12 Hrs

Production and Cost Analysis:

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least- cost combination– Short run and Long run Production Function- Isoquants and Isocosts, MRTS - Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost & Break-Even Analysis - Cost concepts and Cost behavior- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems)-Managerial significance and limitations of Break-Even Analysis.

UNIT – III 8 Hrs

Business Organizations and Markets:

Introduction – Nature, meaning, significance, functions and advantages. Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies

UNIT – IV 10 Hrs

Capital Budgeting:

Introduction – Nature, meaning, significance, functions and advantages. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals, Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

UNIT – V 8 Hrs

Financial Accounting and Analysis:

Introduction – Nature, meaning, significance, functions and advantages. Concepts and Conventions- Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). ***Financial Analysis*** **-** Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Course Code	ORGANISATIONAL BEHAVIOUR (Common to All branches of Engineering)		L	T	P	C
20A52302			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Define the Organizational Behaviour, its nature and scope.
CO2	Understand the nature and concept of Organizational behavior.
CO3	Apply theories of motivation to analyse the performance problems.
CO4	Analyse the different theories of leadership
CO5	Evaluate group dynamics.
CO6	Develop as powerful leader.

UNIT – I 8 Hrs

Introduction to Organizational Behavior:

Meaning, definition, nature, scope and functions - Organizing Process – Making organizing effective-Understanding Individual Behaviour –Attitude -Perception - Learning – Personality.

UNIT – II 12 Hrs

Motivation and Leading:

Theories of Motivation- Maslow's Hierarchy of Needs - Hertzberg's Two Factor Theory - Vroom'stheory of expectancy – Mc Cleland's theory of needs–Mc Gregor's theory X and theory Y– Adam's equity theory – Locke's goal setting theory– Alderfer's ERG theory .

UNIT – III 8 Hrs

Organizational Culture:

Introduction – Meaning, scope, definition, Nature - Organizational Climate - Leadership - TraitsTheory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of good Leader- Conflict Management -Evaluating Leader- Women and Corporate leadership.

UNIT – IV 10 Hrs

Group Dynamics:

Introduction – Meaning, scope, definition, Nature- Types of groups - Determinants of group behavior- Group process – Group Development - Group norms - Group cohesiveness - Small Groups - Groupdecision making - Team building - Conflict in the organization– Conflict resolution

UNIT – V 8 Hrs

Organizational Change and Development:

Introduction –Nature, Meaning, scope, definition and functions- Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization's change and development

Course Code	Business Environment (Common to All branches of Engineering)		L	T	P	C
20A52303			3	0	0	3
Pre-requisite	NIL	Semester	III			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Define Business Environment and its Importance.
CO2	Understand various types of business environment.
CO3	Apply the knowledge of Money markets in future investment.
CO4	Analyse India's Trade Policy.
CO5	Evaluate fiscal and monitory policy.
CO6	Develop a personal synthesis and approach for identifying business opportunities.

UNIT – I 8 Hrs

Overview of Business Environment:

Introduction – meaning Nature, Scope, significance, functions and advantages. Types-Internal &External, Micro and Macro. Competitive structure of industries -Environmental analysis-advantages & limitations of environmental analysis& Characteristics of business.

UNIT – II 12 Hrs

Fiscal & Monetary Policy:

Introduction – Nature, meaning, significance, functions and advantages. Public Revenues - Public Expenditure - Evaluation of recent fiscal policy of GOI. Highlights of Budget- Monetary Policy - Demand and Supply of Money –RBI -Objectives of monetary and credit policy - Recent trends-Roleof Finance Commission.

UNIT – III 8 Hrs

India's Trade Policy:

Introduction – Nature, meaning, significance, functions and advantages. Magnitude and direction of Indian International Trade - Bilateral and Multilateral Trade Agreements - EXIM policy and role of EXIM bank -Balance of Payments– Structure & Major components - Causes for Disequilibrium in Balance of Payments - Correction measures.

UNIT – IV 10 Hrs

World Trade Organization:

Introduction – Nature, significance, functions and advantages. Organization and Structure - Role and functions of WTO in promoting world trade - GATT -Agreements in the Uruguay Round – TRIPS, TRIMS - Disputes Settlement Mechanism - Dumping and Anti-dumping Measures.

UNIT – V 8 Hrs

Money Markets and Capital Markets:

Introduction – Nature, meaning, significance, functions and advantages. Features and components of Indian financial systems - Objectives, features and structure of money markets and capital markets - Reforms and recent development – SEBI – Stock Exchanges - Investor protection and role of SEBI, Introduction to international finance.

Course Code	**Applied Thermodynamics Lab**		**L**	**T**	**P**	**C**
20A03401P			**0**	**0**	**3**	**1.5**
Pre-requisite	**NIL**	**Semester**	**IV**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Explain different working cycles of engine
CO2	Describe various types of combustion chambers in IC engines
CO3	Illustrate the working of refrigeration and air conditioning systems
CO4	Evaluate heat balance sheet of IC engine.

LABORATORY EXPERIMENT LIST

S. No	**Title of the Experiments**
1.	Valve timing diagram of 4-stroke diesel engine
2.	Port timing diagram of 2-stroke petrol engine
3.	Performance of 2-stroke single cylinder petrol engine
4.	Morse test on multi cylinder petrol engine
5.	Performance of 4-stroke single cylinder diesel engine
6.	Assembly and disassembly of diesel and petrol engines
7.	Exhaust gas analysis
8.	Performance of two stage reciprocating air compressor
9.	Determination of nozzle characteristics
10.	Performance of Refrigeration system

11.	Performance of Air conditioning system
12.	Performance of heat pump

Course Code	Manufacturing Technology Lab		L	T	P	C
20A03403P			0	0	3	1.5
Pre-requisite	NIL	Semester	IV			

Course Outcomes:
At the end of the course, students will have the ability to:

CO1	Implement the concept of machining with various machine tools. (L5)
CO2	Get hands on experience on various machine tools and machining operations. (L5)

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Demonstration of operations on general purpose machines: Lathe, drilling, milling, shaper,slotting, cylindrical and surface grinding machines.
2.	Step turning and knurling on lathe machine
3.	Taper turning and knurling on lathe machine
4.	Thread cutting (left hand or right hand) on lathe machine.
5.	Drilling and Boring operations.
6.	Reaming and tapping operations.
7.	Milling (Gear cutting) by using simple and Compound indexing.
8.	key way/Groove cutting on milling machine
9.	Shaping and planning operations
10.	Slotting operations
11.	Cylindrical and surface grinding operations
12.	Grinding of single point cutting tool

Course Code	Computer Aided Machine Drawing		L	T	P	C
20A03404			0	0	3	1.5
Pre-requisite	NIL	Semester	IV			

Course Outcomes:
At the end of the course, students will have the ability to:

CO1	Use the conventional representations of materials and machine components
CO2	Model various riveted, welded and key joints
CO3	Generate solid models and sectional views of machine components
CO4	Develop solid models of machine parts and assemble them
CO5	Generate the sectional views of assembled components

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**The following contents are to be done by any 2D software package Conventional representation of materials and components:** **Detachable joints:** Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted jointwith washer and locknut, stud joint, screw joint and foundation bolts. **Riveted joints:** Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveteddouble strap joints.

	Welded joints: Lap joint and T joint with fillet, butt joint with conventions. **Keys:** Taper key, sunk taper key, round key, saddle key, feather key, woodruff key. **Couplings**: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's' coupling. **The following contents to be done by any 3D software packageSectional views** Creating solid models of complex machine parts and create sectional views. **Assembly drawings: (Any four of the following using solid model software)** Lathe tool post, tool head of shaping machine, tail stock, machine vice, gate valve, carburettor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling, **Manufacturing drawing:** Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Course Code	**Soft Skills**		**L**	**T**	**P**	**C**
20A52401			**1**	**0**	**2**	**2**
Pre-requisite	**NIL**	**Semester**	**IV**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Memorize various elements of effective communicative skills
CO2	Interpret people at the emotional level through emotional intelligence
CO3	apply critical thinking skills in problem solving
CO4	analyse the needs of an organization for team building
CO5	Judge the situation and take necessary decisions as a leader
CO6	Develop social and work-life skills as well as personal and emotional well-being

UNIT – I 10 Hrs

Soft Skills & Communication Skills:

Introduction, meaning, significance of soft skills – definition, significance, types of communication skills -Intrapersonal & Inter-personal skills - Verbal and Non-verbal Communication

Activities:

Intrapersonal Skills- Narration about self- strengths and weaknesses- clarity of thought – self-expression
– articulating with felicity
(The facilitator can guide the participants before the activity citing examples from the lives of the great,anecdotes and literary sources)

Interpersonal Skills- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups -Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic. **Verbal Communication**- Oral Presentations- Extempore- brief addresses and speeches- convincing-negotiating- agreeing and disagreeing with professional grace.

Non-verbal communication – Public speaking – Mock interviews – presentations with an objective toidentify non- verbal clues and remedy the lapses on observation

UNIT – II 12 Hrs

Critical Thinking:

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness –Creative Thinking

Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues – placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT – III 8 Hrs

Problem Solving & Decision Making:

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Methods of decision making – Effective decision making in teams – Methods & Styles

Activities:

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

Case Study & Group Discussion

UNIT – IV 10 Hrs

Emotional Intelligence & Stress Management:

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation– Stress factors – Controlling Stress – Tips

Activities:

Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, and sympathy, and confidence, compassion in the form of written or oral presentations. Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates

UNIT – V 8 Hrs

Leadership Skills:

Team-Building – Decision-Making – Accountability – Planning – Public Speaking – Motivation – Risk- Taking - Team Building - Time Management

Activities:

Forming group with a consensus among the participants- choosing a leader- encouraging the group members to express views on leadership- democratic attitude- sense of sacrifice – sense of adjustment – vision – accommodating nature- eliciting views on successes and failures of leadership using the past knowledge and experience of the participants, Public Speaking, Activities on Time Management, Motivation, Decision Making, Group discussion etc.

NOTE-:

1. The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes, epics, scriptures, autobiographies and literary sources which bear true relevance to the prescribedskill.
2. Case studies may be given wherever feasible for example for Decision Making- The decision of King Lear or for good Leadership – Mahendar Singh Dhoni etc.

Course Code	**Design Thinking for Innovation (Common to All branches of Engineering)**		**L**	**T**	**P**	**C**
20A99401			**2**	**1**	**0**	**0**
Pre-requisite	**NIL**	**Semester**	**IV**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Define the concepts related to design thinking.
CO2	Explain the fundamentals of Design Thinking and innovation.
CO3	Apply the design thinking techniques for solving problems in various sectors.
CO4	Analyse to work in a multidisciplinary environment.
CO5	Evaluate the value of creativity.
CO6	Formulate specific problem statements of real time issues.

UNIT – I 10 Hrs

Introduction to Design Thinking:

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT – II 10 Hrs

Design Thinking Process:

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brain storming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT – III 8 Hrs

Innovation:

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT – IV 10 Hrs

Product Design:

Problem formation, introduction to product design, Product strategies, Product value, Product planning,product specifications. Innovation towards product design Case studies.

Activity: Importance of modelling, how to set specifications, Explaining their own product design.

UNIT – V 8 Hrs

Design Thinking in Business Processes:

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, About maintenance, Reliability and plan for startup.

Semester–V						
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	20A03501	CAD/CAM	3	0	0	3
2.	20A03502	Design of Machine Members	3	0	0	3
3.	20A03503T	Metrology and Measurements	3	0	0	3
4.	20A03504a 20A03504b 20A03504c	**Professional Elective - I** Automation & Robotics Tool Design Power Plant Engineering	3	0	0	3
5.		**Open Elective – I**	3	0	0	3
6.	20A03503P	Metrology and Measurements Laboratory	0	0	3	1.5
7.	20A03506	Computer Aided Modeling Laboratory	0	0	3	1.5
8.	20A03507	**Skill oriented course - III** Innovation through IoT	1	0	2	2
9.	20A03508	Evaluation of Community Service Project				1.5
					Total	**21.5**

Open Elective Course – I

S. No.	Course Code	Course Name	Offered by the Dept.
1	20A01505	Building Technology	CE
2	20A02505	Electric Vehicles	EEE
3	20A04505	Digital Electronics	ECE
4	20A05505a	Java Programming	CSE & Allied /IT
5	20A05602T	Artificial Intelligence	
6	20A12502	Mobile Application Development using Android	
7	20A27505	Computer Applications in Food Processing	FT
8	20A56501	Materials Characterization Techniques	Physics
9	20A51501	Chemistry of Energy Materials	Chemistry

Course Code	**CAD/CAM**		**L**	**T**	**P**	**C**
20A03501			**3**	**0**	**0**	**3**
Pre-requisite	**NIL**	**Semester**	**V**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Apply the basics of geometric representation and transformations in CAD/CAM.
CO2	Choose geometric modelling methods for building CAD models.
CO3	Compare NC, CNC and DNC.
CO4	Develop manual and computer aided part programming for turning and milling operations.
CO5	Summarize the principles of robotics AR, VR and AI in CIM.

UNIT – I 10 Hrs

Introduction to CAD/CAM

CAD/CAM: Introduction, hardware and software, I/O devices, benefits. Graphics standards-Neutralfile formats – IGES, STEP.

2D and 3D geometric transformations: Translation, scaling, rotation, mirroring, homogenous transformations, concatenation of transformations, viewing transformations.

UNIT – II 10 Hrs

Geometric Modelling

Parametric representation: Representation of curves, Hermite curves, Spline, Bezier and B-spline curves in twodimensions; Geometric modelling of surfaces: Surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, sweep surfaces, surface of revolution, blending of surfaces **Geometric Modelling of Solids:** Wireframe, surface modelling, solid entities, Boolean operations,CSG approach and B-rep of solid modelling, geometric modelling of surfaces.

UNIT – III 8 Hrs

Computer Aided Manufacturing (CAM)

Computer Aided Manufacturing (CAM): Structure of numerical control (NC) machine tools, designation of axes, drives and actuation systems, feedback devices, computernumerical control (CNC) and direct numerical control (DNC), adaptive control system, CNC tooling, automatic tool changers and work holding devices, functions of CNC and DNC systems.

UNIT – IV 10 Hrs

Part Programming and APT Programming

Part Programming: Part programming instruction formats, information codes, preparatory functions, miscellaneous functions (G-codes, M-codes). Tool codes and tool length offset, interpolations canned cycles.

APT Programming: APT language structure, APT geometry, Definition of point, line, circle, plane. APT Motion Commands: set-up commands, pint to point motion commands; continuous path motion commands part programming preparation for typical examples (milling and turning operation)

UNIT – V 8 Hrs

Automation

Automation: Anatomy and configuration of robot, characteristics of robots,grippers, application of robots in manufacturing, robot programming languages, Group Technology, Introduction to computer integrated manufacturing, Introduction to Virtual Reality (VR), Augmented Reality (AR) and Artificial Intelligence (AI).

Course Code	DESIGN OF MACHINE MEMBERS		L	T	P	C
20A03502			3	0	0	3
Pre-requisite	NIL	Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Estimate safety factors of machine members subjected to static and dynamic loads.
CO2	Design fasteners subjected to variety of loads.
CO3	Select of standard machine elements such as keys, shafts, couplings, springs and bearings.
CO4	Design clutches brakes and spur gears.

UNIT – I 10 Hrs

Introduction, Design for Static and Dynamic loads

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT – II 10 Hrs

Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints and eccentrically loaded bolted joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentricallyloaded welded joints.

UNIT – III 8 Hrs

Power transmission shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT – IV 10 Hrs

Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT – V 8 Hrs

Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Course Code	METROLOGY AND MEASUREMENTS		L	T	P	C
20A03503T			3	0	0	3
Pre-requisite	Basic Physics and Maths	Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	List various measuring instruments used in metrology.
CO2	Examine geometry of screw threads and gear profiles.
CO3	Measure force, torque and pressure.
CO4	Calibrate various measuring instruments.

UNIT – I 10 Hrs

Concept of measurement

Concept of Measurement: General concept-generalized measurement system, units and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

Limit Gauges And Gauge Design: Plug, Ring, Snap, Gap, Taper gauges. Taylor's principle. Design of Go and No Go gauges.

Linear and Angular Measurement: Linear measuring instruments: Vernier instruments, micrometers, slip gauges, tool makers microscope. Comparators: Mechanical, pneumatic and electrical. **Angular measurements:** Sine bar, bevel protractor and angle dekkor, rollers and spheres used to determine the tapers.

UNIT – II 10 Hrs

Flatness and Surface Roughness measurement

Flatness Measurement: Measurement of flatness – straight edges – surface plates, optical flat and autocollimators, interferometers and their applications.

Surface Roughness Measurement: Terminology systems, differences between surface roughness and surface waviness- Numerical assessment of surface finish - CLA, R.M.S Value- Ra , Rz values, Methods of measurement of surface finish-profilograph, talysurf, BIS symbols for indication of surface roughness.

UNIT – III 8 Hrs

Screw Thread and Gear Measurement

Screw thread measurements: Elements of threads, errors in screw threads, various methods for measuring external and internal screw threads, screw thread gauges.

Gear Measurement: Gear tooth terminology, measurement of gear elements-run out, lead, pitch backlash, profile, pressure angle, tooth thickness, diameter of gear, constant chord and base tangent method.

Coordinate Measuring Machine (CMM)- Construction and features.

UNIT – IV 10 Hrs

Measurement of Displacement and Strain

Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezo-electric, inductive, capacitance, resistance, ionization and photoelectric transducers, calibration procedures.

Measurements of Strain: Various types of electrical strain gauges, gauge factor, method of usage of resistance strain gauge for bending, compressive and tensile strains, usage for measuring torque, strain gauge rosettes.

UNIT – V 8 Hrs

Measurement of Force, Torque and Pressure

Measurement of Force: Direct method - analytical balance, platform balance; elastic members – loadcells, cantilever beams and proving rings.

Measurement of Torque: Torsion bar dynamometer, servo controlled dynamometer and absorptiondynamometer.

Measurement of Pressure: Standards and calibration, basic methods of pressure measurement, deadweight gauges and manometers, High and low pressure measurement, Elastic transducers.

Course Code	AUTOMATION AND ROBOTICS		L	T	P	C
20A03504a			3	0	0	3
Pre-requisite	Mechanical engineering, electrical engineering and control systems	Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Classify the types of hardware components of automation and control system.
CO2	Design a simple material handling system for low-cost manufacturing
CO3	Design a simple gripper for robot
CO4	Compare the types of actuators used in robot manipulator
CO5	Understand the requirements and features of robot programming
CO6	Demonstrate the various applications of robots in manufacturing

UNIT – I 10 Hrs

Introduction: Automation in production system, need, types, Principles and Strategies of automation, levels of automation, basic elements of an automated system, hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertiondevices.

Automated flow lines& transfer mechanisms, fundamentals of transfer Lines, flow lines with or without buffer storage.

UNIT – II 10 Hrs

Assembly Line Balancing and Automated Manufacturing System

Assembly Line Balancing: Assembly process and systems assembly line, line balancing algorithms, ways of improving line balance, flexible assembly lines.

Material handling and Identification Technologies: Overview of automatic material handling systems, principles and design consideration, material transport systems, storage systems, overview of automatic identification methods.

Automated Manufacturing Systems: Components, classification and overview of manufacturing systems, manufacturing cells, GT and cellular manufacturing, FMS and its planning and implementation.

UNIT – III 8 Hrs

Introduction to Robotics

Introduction: Brief history of robots, classification of robot, functional line diagram, degrees of freedom. Elements of robot - types and its functions, factors to be considered in the design of grippers.

Robot Actuators And Feedback Components: Actuators, Pneumatic, Hydraulic actuators, Electric &Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocitysensors, Tactile sensors, Proximity sensors.

UNIT – IV 10 Hrs

Kinematics and Dynamics of a Manipulator

Manipulator Kinematics: Homogenous transformations as applicable to translation, rotations-D-Hnotation, Forward and inverse kinematics.

Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton -Euler formations.

UNIT – V 8 Hrs

Robot Programming and Applications+

Robot Programming: Methods of programming - requirements and features of programming languages, software packages, problems with programming languages. Motion path control- slew motion, joint integrated motion, straight line motion; avoidance of obstacles.

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading;Process - spot and continuous arc welding & spray painting; Assembly and Inspection.

Course Code	TOOL DESIGN		L	T	P	C
20A03504b			3	0	0	3
Pre-requisite	Basic Materials Science, basic physics and basic chemistry	Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Compare the Ferrous and non ferrous tool materials
CO2	Classify the types of chip formation during orthogonal cutting
CO3	Design Drill Jigs and Fixtures
CO4	Design a simple gripper for robot
CO5	Understand the concept of design of die and piercing operations
CO6	Understand about the tool holding methods, Automatic tool changers and tool positions in CNCMachine

UNIT – I 10 Hrs

INTRODUCTION TO TOOL DESIGN

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings - Surface finish

Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials-Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment.

UNIT – II 10 Hrs

DESIGN OF CUTTING TOOLS

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

UNIT – III 8 Hrs

DESIGN OF JIGS AND FIXTURES

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gauges – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Types of Fixtures – Vice Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures.

UNIT – IV 10 Hrs

DESIGN OF PRESS TOOL DIES

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Centre of pressure - Strip layout – Short-run tooling for Piercing – Bending dies – Drawing dies-Design and drafting.

UNIT – V 8 Hrs

TOOL DESIGN FOR CNC MACHINE TOOLS

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Course Code	POWER PLANT ENGINEERING		L	T	P	C
20A03504c			3	0	0	3
Pre-requisite		Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Outline sources of energy, power plant economics, and environmental aspects
CO2	Explain power plant economics and environmental considerations
CO3	Describe working components of a steam power plant
CO4	Illustrate the working mechanism of Diesel and Gas turbine power plants
CO5	Summarize types of renewable energy sources and their working principle
CO6	Demonstrate the working principle of nuclear power plants

UNIT – I 10 Hrs

Introduction to the Sources of Energy

Introduction to the Sources of Energy - Resources and Development of Power in India. Layouts of Steam, Hydel, Diesel, MHD, Nuclear and Gas Turbine Power Plants - Combined Power Cycles - Comparison and Selection.

Power Plant Economics and Environmental Considerations: Capital Cost, Investment of Fixed Charges, Operating Costs, General Arrangement of Power Distribution, Load Curves, Load Duration Curve. Definitions of Connected Load, Maximum Demand, Demand Factor, Average Load, Load Factor, Diversity Factor - Tariff - Related Exercises. Effluents from Power Plants and Impact on Environment - Pollutants and Pollution Standards - Methods of Pollution Control. Inspection And Safety Regulations.

UNIT – II 10 Hrs

Steam Power Plant

Modern High Pressure and Supercritical Boilers - Analysis of Power Plant Cycles - Modern Trends in Cycle Improvement - Waste Heat Recovery, Fluidized Bed Boilers., Fuel and Handling Equipments, Types of Coals, Coal Handling, Choice of Handling Equipment, Coal Storage, Ash Handling Systems. Combustion Process- Properties of Coal - Overfeed and Under Feed Fuel Beds, Travelling Grate Stokers, Spreader Stokers, Retort Stokers, Pulverized Fuel Burning System And Its Components, Combustion Needs and Draught System, Cyclone Furnace, Design and Construction, Dust Collectors, Cooling Towers And Heat Rejection. Analysis of Pollution from Thermal Power Plants - Pollution Controls.CO_2 Recorders

UNIT – III 8 Hrs

Diesel and Gas Turbine Power Plants

Diesel Power Plant: Diesel Power Plant: Introduction - IC Engines, Types, Construction- Fuel Storage

Gas Turbine Plant: Introduction - Classification - Construction - Principles of Working Closed andOpen Cycle Gas Turbines. Advantages And Disadvantages Combined Cycle Power Plants.

UNIT – IV 10 Hrs

Hydro Electric Power Plants

Hydro Electric Power Plant: Waterpower - Hydrological Cycle / Flow Measurement - DrainageArea Characteristics - Hydrographs - Storage and Pondage - Classification of Dams and Spill Ways.

Hydro Projects & Plant: Classification - Plant Auxiliaries - Plant Operation Pumped Storage Plants.

UNIT – V 8 Hrs

Non-Conventional Source of Energy

Power From Non-Conventional Sources: Utilization of Solar Collectors- Principle of its Working, Wind Energy - Types of Turbines - HAWT & VAWT-Tidal Energy. MHD power Generation.

Nuclear Power Station: Nuclear Fuel - Nuclear Fission, Chain Reaction, Breeding and Fertile Materials - Nuclear Reactor -Reactor Operation.

Types Of Reactors: Pressurized Water Reactor, Boiling Water Reactor, Sodium-Graphite Reactor, Fast breeder Reactor, Homogeneous Reactor, Gas Cooled Reactor, Radiation Hazards and Shielding -Radioactive Waste Disposal.

Course Code	METROLOGY AND MEASUREMENTS LAB		L	T	P	C
20A03503P			0	0	3	1.5
Pre-requisite		Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Apply different instruments to measure length, width, depth, bore diameters, internal andexternal tapers, tool angles, and surface roughness.
CO2	Measure effective diameter of thread profile.
CO3	Conduct different machine alignment tests.
CO4	Measure temperature, displacement, and pressure.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
	Section A:
1.	Measurement of bores by internal micrometers and dial bore indicators.
2.	Use of gear teeth Vernier callipers and checking the chordal addendum and chordal height ofspur gear.
3.	Alignment test on the lathe and milling machine using dial indicators
4.	Study of Tool makers microscope and its application
5.	Angle and taper measurements by Bevel protractor, Sine bar spirit level etc.
6.	Thread measurement by Two wire/Three wire method.

7.	Surface roughness measurement by Talysurf instrument.
8.	Use of straight edge and sprit level in finding the flatness of surface plate.
Section B:	
1.	Calibration of Pressure Gauges
2.	Study and calibration of Mcleod gauge for low pressure.
3.	Calibration of transducer or thermocouple for temperature measurement.
4.	Calibration of LVDT transducer for displacement measurement.
5.	Calibration of capacitive transducer for angular measurement.
6.	Calibration of photo and magnetic speed pickups for the measurement of speed.
7.	Study and use of a Seismic pickup for the measurement of vibration amplitude of an enginebed at various loads.

Course Code	**COMPUTER AIDED MODELING LABORATORY**		**L**	**T**	**P**	**C**
20A03506			**1**	**0**	**2**	**2**
Pre-requisite	**Basic computer science, mechanical engineering and engineering drawing**	**Semester**	**V**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Students will be able to design different parts of mechanical equipment's
CO2	Students will be able to apply their skills in various designing and Manufacturing Industries.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Generation of the following curves using "C"/ Python language a) Cubic Splines b) Bezier curves c) B-Splines.
2.	Generation of the following surfaces using "C"/Python language a) Bezier surfaces a) B-Spline surfaces
3.	Typical tasks of Modeling using any solid modeling packages such as PRO/E, IDEAS, CATIA,etc., a) Solid Boolean algebra - 1 Exercise b) Wireframe &Surface Modelling – 3 Exercises c) 3D – Drafting in detail – 1 Exercise d) Production Drawing with Geometric Dimensioning and Tolerances– 3 Exercises (Preferably for the assembly drawings drawn in Computer Aided Machine Drawing in previoussemester)

Course Code	INNOVATION THROUGH IoT		L	T	P	C
20A03507			1	0	2	2
Pre-requisite	Basic computer science and engineering	Semester	V			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Write a program of Raspberry Pi/Arduino for IoT applications
CO2	Understand the relationship between IoT, Cloud services and Software agents
CO3	Explain the troubleshooting methods in IoT based systems
CO4	Apply the design thinking concepts to any type of IoT based applications
CO5	Define a problem statement by conducting the survey
CO6	Design a creative solution for a specified problem.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Module 1** Introduction to Micro Controllers: Exp 1: Programming of Raspberry Pi3 / Arduino. Exp 2: Peripheral interfacing to the microcontroller.
2.	**Module 2** Introduction and applications of IoT , Cloud services & Software Agents: Exp 1: Trace the relationship between IoT, Cloud services and Software agents. Exp 2: Troubleshooting the microcontroller-based systems (IoT based systems or Products).
3.	**Module 3** Introduction to Design & Concepts of IoT: Using the concepts of IoT, Implement the 5 stages(Empathize, Define, Prototype, Ideate, Test) of Design thinking for the following Exp 1: Measurement of temperature and humdity (whether monitoring). Exp 2: Soil monitoring (Temperature, Humidity, Phosphorus, Zinc, Iron) / Crop Monitoring.Exp 3: Design of automatic car wiper for rain sensing Exp 4: Intelligent transportation systemExp 5: Vehicle monitoring system Exp 6: Traffic monitoring and control Exp 7: Design a device for Fleet and driver management.Exp 8: Smart lighting system Exp 9: Smart parking systems Exp 10: Development of Smart citiesExp 11: Measurement of water level
4.	**Module 4:** Conduct survey and identify the problem on the above experiments, either individual/group and toavail problem statement for further development.
5.	**Module 5:**

	With the help of problem statement in experiment 6, draw product/system after applying CREATE (Combine, Rearrange, Enhance, Adapt, Turn around, Eliminate) Tool.
6.	**Module 6:** Story boarding of design ideas to transform ,'information about needs' into design concepts.

Semester–VI						
S.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	20A03601	Dynamics of Machinery	3	0	0	3
2.	20A03602	Finite Element Methods (FEM)	3	0	0	3
3.	20A03603T	Heat Transfer	3	0	0	3
4.	20A03604a 20A03604b 20A03604c	**Professional Elective – II** Non-Destructive Testing (NDT) Production and operations management Total Quality Management (TQM)	3	0	0	3
5.		**Open Elective Course – II**	3	0	0	3
6.	20A03606	Computer Aided Design Laboratory	0	0	3	1.5
7.	20A03607	Computer Aided Manufacturing Laboratory	0	0	3	1.5
8.	20A03603P	Heat Transfer Laboratory	0	0	3	1.5
9.	20A03608	**Skill oriented course - IV** 3D Printing practice	1	0	2	2
10.	20A99601	**Mandatory Non-credit Course** Intellectual Property Rights & Patents	2	0	0	0
Total						**21.5**
Industry Internship (Mandatory) for 6 - 8 weeks duration during summer vacation						

Open Elective Course – II

S.No	Course Code	Course Name	Offered by the Dept.
1	20A01704	Environmental Economics	CE
2	20A02605	Smart Electric Grid	EEE
3	20A04605	Signal Processing	ECE
4	20A04701b	Introduction to Internet of Things	ECE/CSE
5	20A05605a	Principles of Operating Systems	CSE & Allied /IT
6	20A05605b	Foundations of Machine Learning	
7	20A05605c	Data Analytics Using R	
8	20A27605	Food Refrigeration and Cold Chain Management	FT
9	20A54701	Wavelet Transforms & its applications	Mathematics
10	20A56701	Physics Of Electronic Materials and Devices	Physics
11	20A51701	Chemistry of Polymers and its Applications	Chemistry

Course Code	DYNAMICS OF MACHINERY		L	T	P	C
20A03601			3	0	0	3
Pre-requisite	Static and dynamic force analysis, vibration etc.,	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Determine the forces acting on various linkages when a mechanism is subjected to external forces.
CO2	Identify and correct the unbalances of rotating body
CO3	Analyze the vibratory motion of SDOF systems.
CO4	Reduce the magnitude of vibration and isolate vibration of dynamic systems
CO5	Determine dimensions of Governors for speed control.

UNIT – I 10 Hrs

Friction and Power Screws

Friction: Inclined plane, friction of screws and nuts, pivot and collar, uniform pressure, uniform wear.Friction circle and friction axis, lubricated surfaces, boundary friction, film lubrication.

Power screws: Forms of threads, self locking of screws, efficiency of different screws, Square,trapezoidal, screw threads.

UNIT – II 10 Hrs

Precession, Turning Moment Diagram and Fly Wheel

Precession: Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motorcycle, aeroplanes and ships.

Turning Moment Diagrams and Fly Wheels: Turning moment diagrams for steam engine, IC Engine and multi cylinder engine. Crank effort - coefficient of Fluctuation of energy, coefficient of Fluctuation of speed – Fly wheels and their design, Fly wheels for Punching machines.

UNIT – III 8 Hrs

Governors

Watt, Porter and Proell governors. Spring loaded governors – Hartnell and Hartung governors withauxiliary springs. Sensitiveness, isochronism and hunting. Effort and power of a governor.

UNIT – IV 10 Hrs

Balancing

Balancing: Balancing of rotating masses - single and multiple – single and different planes. Balancing Of Reciprocating Masses: Primary and Secondary balancing of reciprocatingmasses. Analytical and graphical methods. Unbalanced forces and couples – V-engine, multi cylinder inlineand radial engines for primary and secondary balancing.

UNIT – V 8 Hrs

Vibration

Free and forced vibration of single degree of freedom system, Role of damping, whirling of shafts and critical speeds. Simple problems on free, forced and damped vibrations. Vibration Isolation & Transmissibility. Transverse vibrations of beams with concentrated and distributed loads. Dunkerly's method, Raleigh's method. Torsional vibrations - two and three rotor systems.

Course Code	FINITE ELEMENT METHODS		L	T	P	C
20A03602			3	0	0	3
Pre-requisite	Basic mathematics, linear and tensor algebra, differential and integral calculus and complex numbers	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understand the concepts behind variational methods and weighted residual methods in FEM.
CO2	Identify the application and characteristics of FEA elements such as bars, beams, andisoparametric elements, and 3-D element.
CO3	Develop element characteristic equation procedure and generation of global stiffness equationwill be applied.
CO4	Able to apply Suitable boundary conditions to a global structural equation, and reduce it to asolvable form.
CO5	Able to identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer and fluid flow.

UNIT – I 10 Hrs

Introduction to finite element methods

Introduction to finite element methods for solving field problems, applications, Stress and equilibrium, Boundary conditions, Strain-Displacement relations, Stress- strain relations for 2D and 3D Elastic problems. Potential energy and equilibrium, Rayleigh-Ritz method, Formulation of Finite Element Equations.

One dimensional Problems: Finite element modelling of ID bar elements coordinates and shape functions. Requirements for Convergence and Interpolation functions, Pascal's Triangle, Assembly of global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT – II 10 Hrs

1 D Analysis of Trusses and Beams

Analysis of trusses: Stiffness Matrix for 1D truss element, Stress Calculations and Problems withmaximum of three elements.

Analysis of beams: Element Stiffness Matrix and Load vector for 1 D beam element, Hermite shapefunctions and simple problems.

UNIT – III 8 Hrs

2D Analysis

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load Vector, Stresses.

Finite element modeling of Axi-symmetric solids subjected to axi-symmetric loading with triangularelements.

UNIT – IV 10 Hrs

Quadrilateral Elements & Thermal Analysis

Quadrilateral Elements: Isoparametric, Sub parametric and Super parametric elements, Modelling of 4 noded and 8 noded quadrilateral elements and simple problems. Numerical Integration.

Steady state heat transfer analysis: One dimensional analysis of composite slab and fin.

UNIT – V 8 Hrs

Dynamic analysis

Analysis of a 1D uniform shaft subjected to torsion – Simple problems

Dynamic analysis: Formulation of finite element model, element – mass matrices, evaluation ofEigen values and Eigen vectors for a bar and shaft.

Course Code	HEAT TRANSFER		L	T	P	C
20A03603			3	0	0	3
Pre-requisite	Basic calculus, differential equations and basic fluid science	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Apply the concepts of different modes of heat transfer.
CO2	Apply knowledge of conduction heat transfer in the design of insulation of furnaces andpipes.
CO3	Analyse free and forced convection phenomena in external and internal flows.
CO4	Design of thermal shields using the concepts of black body and non-black body radiation.
CO5	Apply the basics of mass transfer for applications in diffusion of gases.

UNIT – I 10 Hrs

Introduction

Basic modes of heat transfer- rate equations- generalized heat conduction equation-various forms - steady state heat conduction solution for plane and composite slabs - cylinders - critical thickness of insulation- heat conduction through fins of uniform cross section- fin effectiveness and efficiency.

Unsteady State Heat Transfer Conduction- Transient heat conduction- lumped system analysis and use of Heisler charts.

UNIT – II 10 Hrs

Convection

Convection: Basic concepts of convection–heat transfer coefficients - types of convection – forced convection and free convection.

Free Convection: development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation

Forced convection: in external flow–concepts of hydrodynamic and thermal boundary layer-use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy, approximate solution to laminar boundary layer equation for external flow. Internal flow – Use of empirical relations for convective heat transfer in horizontal pipe flow-problems.

UNIT – III 8 Hrs

Boiling and Condensation

Different regimes of boiling- nucleate, transition and film boiling – condensation – film wise and dropwise condensation-problems.

UNIT – IV 10 Hrs

Heat Exchangers

Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers-problems.

UNIT – V 8 Hrs

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect- simple problems.

Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass - Equimolal diffusion- - diffusion of gases and liquids- mass transfer coefficient.

Course Code	NON-DESTRUCTIVE TESTING (NDT)		L	T	P	C
20A03604a			3	0	0	3
Pre-requisite	Basic mathematics (algebra, geometry, and trigonometry), physics, chemistry, and computer science	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Explain various methods of non-destructive testing.
CO2	Apply relevant non-destructive testing method different applications.
CO3	Explain the applications of railways, nuclear and chemical industries.
CO4	Outline the limitations and disadvantages of nde.
CO5	Explain the applications of NDA of pressure vessels, casting and welding constructions

UNIT – I 10 Hrs

Introduction to non-destructive testing: Radiographic test**,** Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography.

UNIT – II 10 Hrs

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect , Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT – III 8 Hrs

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing**.**

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current-Testing Effectiveness of Eddy Current Testing.

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

UNIT – IV 10 Hrs

Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography– Contact and non contact thermal inspection methods–Heat sensitive paints –Heat sensitive

papers –-thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behavior of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

UNIT – V 8 Hrs

Industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

Course Code	PRODUCTION AND OPERATIONS MANAGEMENT		L	T	P	C
20A03604b			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate the operations and supply management to the sustainability of an enterprise
CO2	Identify the need for forecasting and understand different forecasting methods
CO3	Identify various production and plant layouts
CO4	Examine the quality control of the production
CO5	Apply Just in Time (JIT) basic principles and applications
CO6	Recommend the production schedule for productivity
CO7	Design, analyze and implement single machine, parallel machine, flow shop and job shopscheduling algorithms

UNIT – I 10 Hrs

Introduction: Operations Management – Definition, Objectives, Types of Production System, Difference between OM & PM, Historical Development of Operations Management, Current Issues in Operation Management, Product Design – Requirements of Good Product Design, Product Development – Approaches, Concepts in Product. Development, Standardization, Simplification, Speed to Market, Introduction to Concurrent Engineering.

UNIT – II 10 Hrs

Forecasting: Introduction, Statistical Forecasting Techniques, Moving Average, Exponential Smoothing Technique, Errors in Forecasting and Evaluation of Forecasting Techniques.

UNIT – III 8 Hrs

Value Engineering and Plant Layout: Value Engineering – Objectives, Types of Values, Function and Cost, Product Life Cycle, Steps in Value Engineering, Methodology in Value Engineering, FAST Diagramand Matrix Method. Facility Location and Layout – Factor Considerations in Plant Location, Comparative Study of Rural and Urban Sites, Methods of Selection of Plant Layout, Objectives of Good layout, Principles, Types of Layout, Line Balancing

UNIT – IV 10 Hrs

Aggregate Planning and MRP: Aggregate Planning – Definition, Different Strategies, Various Models of Aggregate Planning- Transportation and Graphical Models, Master scheduling, Material Requirement Planning(MRP)- Terminology, Types of Demands, Inputs to MRP, Techniques of MRP, Lot Sizing Methods, Benefits and Drawbacks of MRP, Manufacturing Resources Planning (MRP II), Just in Time (JIT) Philosophy, Kanban System, Calculation of Number of Kanbans, Pull Systems vs. Push Systems, Requirements for Implementation of JIT, JIT Production Process, Benefits of JIT.

UNIT – V 8 Hrs

Scheduling: Policies, Types of Scheduling, Scheduling Strategies, Scheduling and Loading Guidelines, Forward and Backward Scheduling, Grant Charts, Priority Decision Rules, Flow Shop Scheduling, Job Shop Scheduling, Line of Balance.

Course Code	TOTAL QUALITY MANAGEMENT (TQM)		L	T	P	C
20A03604c			3	0	0	3
Pre-requisite	Management skills	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Develop an understanding on quality Management philosophies and frameworks
CO2	Adopt TQM methodologies for continuous improvement of quality
CO3	Measure the cost of poor quality, process effectiveness and efficiency to identifyareas for improvement
CO4	Apply benchmarking and business process reengineering to improve managementprocesses.
CO5	Determine the set of indications to evaluate performance excellence of an organization.

UNIT – I 10 Hrs

Introduction: Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality costs, Basic concepts of Total Quality Management.

UNIT – II 10 Hrs

Historical Review: Quality council, Quality statements, Strategic Planning, Deming Philosophy, Barriers of TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

UNIT – III 8 Hrs

TQM Principles: Customer Satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment teams, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure Case studies.

UNIT – IV 10 Hrs

TQM Tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, The seven tools of quality, Process capability, Concept of Six Sigma, New Seven management tools, Case studies.

UNIT – V 8 Hrs

Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9000: 2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits, Case Studies.

Course Code	COMPUTER AIDED DESIGN LABORATORY		L	T	P	C
20A03606			0	0	3	1.5
Pre-requisite	Engineering Graphics and Basic maths	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Ability to solve engineering problems using the commercial software's such as ANSYS, SIMUFACT, ABAQUS and SIMULIA
CO2	Ability to solve engineering problems using the Mathematical analysis, MAT LAB, GNU Octave, Scilab, MAPLE/ COMSOL.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Static Analysis** **a.** Stress analysis of 2D truss. **b.** Stress analysis of a plate with a circular hole and L-Bracket – 2D and 3D **c.** Stress analysis of beams (cantilever, simply supported & fixed ends) **d.** Stress analysis of an axi-symmetric component **e.** Torsion based Problem
2.	**Thermal Analysis** **a.** Conductive heat transfer analysis of a 2D and 3D components **b.** Conduction and Convective heat transfer analysis of a 2D component **c.** Heat transfer rate of a composite wall **d.** Coupled field analysis of a component
3.	**Modal Analysis** **a.** Mode frequency analysis of a 2D component **b.** Mode frequency analysis of beams (cantilever, simply supported)

Course Code	COMPUTER AIDED MANUFACTURING LABORATORY		L	T	P	C
20A03607			0	0	3	1.5
Pre-requisite	Computer aided design and computer aided manufacturing	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Use and understanding of Preparatory and Miscellaneous (G& M) codes to generate or edit a program which will operate a CNC Lathe/ Milling and Drilling.
CO2	Apply mathematical methods to calculate World/ Joint/ Tool coordinates in robotics.
CO3	Apply the programming concepts of Robots for simple applications in material handling andassembly

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Manual part programming (using G and M codes) in CNC Lathe Machine: **a.** Part programming for linear interpolation, circular interpolation, chamfering and grooving. **b.** Part programming by using standard Canned cycles for facing, turning, taper turning andthread cutting, Chess Bishop profile **c.** Multiple turning operations which cover all lathe operations covering maximum G codesand M codes
2.	Manual part programming (using G and M codes) in CNC Milling Machine: **a.** Part programming for linear interpolation, circular interpolation and contour motions. **b.** Part programming involving canned cycles for drilling, Peck drilling and boring andpocketing & Mirroring. **c.** Part programming for Gear cutting profile
3.	APT (Automatically Programmed Tools) Language-Cutting tool path generation by using anyCAM simulation package / Experiment for different machining operations. **a.** APT Lathe Programming's - 2 Experiments **b.** APT Milling Programming's- 2 Experiments
4.	Robotics: By using 5 or 6 – Axis robot **a.** Pick and Place with palletizing/ de-palletizing of components **b.** Nut, Bolt and Washer Assembly with robot.

Course Code	HEAT TRANSFER LAB		L	T	P	C
20A03603P			0	0	3	1.5
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Explain different modes of heat transfer
CO2	Identify parameters for measurement for calculating heat transfer
CO3	Determine effectiveness of heat exchanger
CO4	Design new equipment related to heat transfer
CO5	Apply principles of heat transfer in wide application in industries.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	Determine the overall heat transfer coefficient across the width of composite wall
2.	Determine the thermal conductivity of a metal rod
3.	Determine the thermal conductivity of insulating powder material through concentric sphereapparatus
4.	Determine the thermal conductivity of insulating material through lagged pipe apparatus
5.	Determine the efficiency of a pin fin in natural and forced convection.
6.	Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
7.	Determine the heat transfer coefficients on film and drop wise condensation apparatus.
8.	Determine the effectiveness of a parallel and counter flow heat exchanger.
9.	Study the pool boiling phenomenon and different regimes of pool boiling.
10.	Experiment on pool boiling
11.	Determine the emissivity of the test plate surface.

12.	Experiment on Stefan-Boltzmann apparatus
13.	Determine the heat transfer rate coefficient in fluidized bed apparatus.

Course Code	3D PRINTING PRACTICE		L	T	P	C
20A03608			0	0	3	1.5
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Explain different types of 3d Printing techniques
CO2	Identify parameters for powder binding and jetting process
CO3	Determine effective use of ABS material for 3D Printing
CO4	Apply principles of mathematics to evaluate the volume of material require.

LABORATORY EXPERIMENT LIST

S. No	Title of the Experiments
1.	**Module 1:** Introduction to Prototyping, Working of 3D Printer, Types of 3D printing Machines:Exp 1: Modelling of Engineering component and conversion of STL format. Exp 2: Slicing of STL file and study of effect of process parameter like layer thickness,orientation, and infill on build time using software. **Exercise 1: Component-1Exercise 2 : Component-2**
2.	**Module 2:** Exp 1: 3D Printing of modelled component by varying layer thickness.Exp 2: 3D Printing of modelled component by varying orientation. Exp 3: 3D Printing of modelled component by varying infill.
3.	**Module 3:** Study on effect of different materials like ABS, PLA, Resin etc, and dimensional accuracy.
4.	**Module 4:** Identifying the defects in 3D Printed components.
5.	**Module 5** Exp1: Modelling of component using 3D Scanner of real life object of unknown dimensionin reverse engineering**.** Exp 2: 3D Printing of above modelled component.

Course Code	INTELLECTUAL PROPERTY RIGHTS AND PATENTS		L	T	P	C
20A99601			0	0	3	1.5
Pre-requisite	**Better identification, planning, commercialization, rendering, and thereby protection of invention or creativity**	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understand IPR law & Cyber law
CO2	Discuss registration process, maintenance and litigations associated with trademarks
CO3	Illustrate the copy right law
CO4	Enumerate the trade secret law.

UNIT – I 10 Hrs

Introduction to Intellectual Property Law – Evolutionary past – Intellectual Property Law Basics – Types of Intellectual Property – Innovations and Inventions of Trade related Intellectual Property Rights – Agencies Responsible for Intellectual Property Registration – Infringement – Regulatory – Overuse or Misuse of Intellectual Property Rights – Compliance and Liability Issues.

UNIT – II 10 Hrs

Introduction to Copyrights – Principles of Copyright – Subject Matters of Copyright – Rights Afforded by Copyright Law –Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of performers – Copyright Formalities and Registration – Limitations – Infringement of Copyright – International Copyright Law- SemiconductorChip Protection Act.

UNIT – III 8 Hrs

Introduction to Patent Law – Rights and Limitations – Rights under Patent Law – Patent Requirements – Ownership and Transfer – Patent Application Process and Granting of Patent – Patent Infringement and Litigation – International Patent Law – Double Patenting – Patent Searching – Patent Cooperation Treaty – New developments in Patent Law- Invention Developers and Promoters.

UNIT – IV 10 Hrs

Introduction to Trade Mark – Trade Mark Registration Process – Post registration procedures – Trade Mark maintenance – Transfer of rights – Inter parties Proceedings – Infringement – Dilution of Ownership of Trade Mark – Likelihood of confusion – Trade Mark claims – Trade Marks Litigation –International Trade Mark Law.

UNIT – V 8 Hrs

Introduction to Trade Secrets – Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreement – Trade Secret Law – Unfair Competition – Trade Secret Litigation – Breach of Contract – Applying State Law. Introduction to Cyber Law – Information Technology Act – Cyber Crime and E-commerce – Data Security – Confidentiality – Privacy – International aspects of Computer and Online Crime.

Course Code	**MODERN MANUFACTURING METHODS**		**L**	**T**	**P**	**C**
20A03701a			**0**	**0**	**3**	**1.5**
Pre-requisite	**Nil**	**Semester**	**VI**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Illustrate advanced machining processes, cutting tools and cutting fluids for a specificmaterial and part features.
CO2	Classify the mechanism of Mechanical Energy based machining processes, its applicationsand limitations.
CO3	Differentiate Electrical Energy Based machining processes, mechanism of metal removal,machine tool selection.

CO4	Interpret Electro Chemical machining process, economic aspects of ECM and problems onestimation of metal removal rate.

UNIT – I 10 Hrs

Non – Traditional Machining Processes: Introduction, Need, Classification and Brief Overview, Considerations in Process selection, Materials, Applications.

Mechanical Energy Based Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultra Sonic Machining – Working Principle, Description of Equipment, Process Parameters, Metal Removal Rate, Applications, Advantages and Limitations.

UNIT – II 10 Hrs

Electrical Energy Based Processes: Electric Discharge Machining – Working Principles, Description of Equipment, Process Parameters, Surface Finish and MRR, Electrode / Tool, Power and Control Circuits, Tool Wear, Dielectric Fluid, Flushing, Advantages, Limitations and Applications. Wire cut EDM – Working Principle and Applications.

UNIT – III 8 Hrs

Chemical and Electro Chemical Energy Based Processes: Chemical Machining and Electro Chemical Machining – Working Principle, Description of Equipment, Etchants, Maskants, Techniques of Applying Maskants, Process Parameters, Surface Finish and MRR, Electro Chemical Grinding, Electro Chemical Honing, Applications, Advantages and Limitations.

UNIT – IV 10 Hrs

Thermal Energy Based Processes: Laser Beam Machining and Drilling, Plasma Arc Machining, Electron Beam Machining – Working Principle, Description of Equipment, Process Parameters, Applications, Advantages and Limitations.

UNIT – V 8 Hrs

Additive Manufacturing: Introduction to Additive Manufacturing, Classification of Additive Manufacturing Processes, Working Principle, Advantages, Limitations and Applications of Sterolithography (SLA), Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing

Course Code	**DESIGN FOR MANUFACTURING**		**L**	**T**	**P**	**C**
20A03701b			**0**	**0**	**3**	**1.5**
Pre-requisite	**Nil**	**Semester**	**VI**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Design mechanical components with economical consideration
CO2	Select materials and machining processes
CO3	Identify the necessity for redesigning components out of manufacturing considerations
CO4	Consider the manufacturing considerations while designing cast, forged weld and sheetmetal components
CO5	Design plastic parts with manufacturing considerations

UNIT – I 10 Hrs

Introduction: Design philosophy-steps in design process-general design rules for manufacturability- basic principles of designing for economical production-creativity in design.

Materials: Selection of materials for design-developments in material technology-criteria for material selection-material selection interrelationship with process selection-process selection charts.

UNIT – II 10 Hrs

Machining processes

Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – III 8 Hrs

Metal Casting and Joining

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design ofbrazed joints

UNIT – IV 10 Hrs

Forging, Extrusion & Sheet metal work

Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking

UNIT – V 8 Hrs

Plastics

Visco elastic and creep behavior in plastics-design guidelines for plastic components-design considerations for injection moulding – design guidelines for machining and joining of plastics.

Course Code	**OPERATIONS RESEARCH**		**L**	**T**	**P**	**C**
20A03701c			**0**	**0**	**3**	**1.5**
Pre-requisite	**Mathematics at high school level, probability distributions and statistics and preferably basic calculus**	**Semester**	**VI**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Develop mathematical models for practical problems.
CO2	Apply linear programming to transportation problems.
CO3	Solve games using various techniques.
CO4	Solve production scheduling and develop inventory policies.
CO5	Apply optimality conditions for constrained and unconstrained nonlinear problems.
CO6	Apply dynamic programming methods.

UNIT – I 10 Hrs

Introduction to Operations Research (OR): OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models

Linear Programming(LP): Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two–Phase Simplex Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Concept of dual theorem

UNIT – II 10 Hrs

Transportation and Assignment Problems

Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution–North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.

UNIT – III 8 Hrs

Game theory & Job Sequencing

Game theory: Optimal solution of two person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. Reduction by principles of dominance, arithmetic, algebraic method and graphical method.

Job Sequencing: Introduction to Job shop Scheduling and flow shop scheduling, Solution of Job Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method.

UNIT – IV 10 Hrs

Queuing Theory & Inventory Control

Queuing Theory: Introduction – Terminology, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with infinite and finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with infinite queue length.

Inventory Control: Introduction, Deterministic models – EOQ model with and without shortages, Production model, Buffer stock and discount inventory models with single price breaks. Selective inventory control.

UNIT – V 8 Hrs

Replacement and Maintenance Analysis & DP

Replacement and Maintenance Analysis: Introduction – Types of Maintenance, Make or buy decision. Types of Replacement Problems, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group Replacement Model.

Dynamic Programming (DP): Introduction –Bellman's Principle of Optimality

Applications of Dynamic Programming – Shortest Path Problem – Capital Budgeting Problem –Solution of Linear Programming Problem by DP.

Course Code	AUTOMOBILE ENGINEERING		L	T	P	C
20A03702a			0	0	3	1.5
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Identify different parts of automobile
CO2	Explain the working of various parts like engine and brakes
CO3	Describe the working of steering and the suspension systems.

CO4	Summarize the wheels and tires
CO5	Outline the future developments in the automobile industry

UNIT – I 10 Hrs

Introduction to vehicle structure and engine components

Vehicle construction - Chassis and body - Specifications - Engine - Types - Construction - Location of engine - Cylinder arrangement - Construction details - Cylinder block - Cylinder head - Cylinder liners - Piston – piston rings - Piston pin - Connecting rod - Crankshaft - Valves. Lubrication system - Types - Oil pumps - Filters. Crankcase ventilation.

UNIT – II 10 Hrs

Ignition and fuel supply systems

Ignition system - Coil and Magneto - Spark plug - Distributor – Electronic ignition system - Fuel system - Carburetor - Fuel pumps - Fuel injection systems - Mono point and Multi point – Unit Injector – Nozzle types - Electronic Fuel Injection system (EFI) – GDI, MPFI, DTSI.

UNIT – III 8 Hrs

Steering and suspension system

Principle of steering - Steering Geometry and wheel alignment - Steering linkages – Steering gearboxes - Power steering - front axle - Suspension system - Independent and Solid axle – coil, leaf spring and air suspensions - torsion bar - shock absorbers.

UNIT – IV 10 Hrs

Wheels, Tyres and Braking System

Wheels and Tyres - Construction - Type and specification - Tyre wear and causes - Brakes - Needs – Classification –Drum and Disc Mechanical - Hydraulic and pneumatic - Vacuum assist – Retarders – Anti-lock Braking System(ABS).

UNIT – V 8 Hrs

Automobile electrical systems and advances in automobile engineering

Battery-General electrical circuits- Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP), Traction Control System (TCS) - Global Positioning System (GPS), Hybrid vehicle, Fuel Cell.

Course Code	**MECHANICAL VIBRATIONS**		**L**	**T**	**P**	**C**
20A03702b			**3**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Semester**	**VI**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Find natural frequency of un-damped single degree freedom systems
CO2	Analyze the two degree freedom systems with and without damping
CO3	Calculate transmissibility and isolation
CO4	Solve problems on vibration absorber
CO5	Calculate natural frequencies of multi degree freedom system
CO6	Measure vibration parameters
CO7	Use mechanical exciters and electro dynamic shaker

UNIT – I 10 Hrs

Single Degree Freedom Systems: Un-damped free vibration: Classical method, Energy method, equivalent systems, torsional systems. Damped free vibration- Viscous damping, under damping, critical damping, over damping. Coulomb damping, equivalent damping coefficient. Simple

problems. **Whirling of shafts: Transverse vibrations:**Dunkerley's lower bound approximation, Critical speed of shafts.

UNIT – II 10 Hrs

Forced vibrations of Single Degree Freedom Systems

Steady state forced vibration, sources of excitation, impressed harmonic force, resonance impressed force due to unbalance, motion excitation, transmissibility and isolation, performance of different typeof isolators, power absorbed by viscous damping.

UNIT – III 8 Hrs

Two Degree Freedom Systems:

Formulation of Equation of motion, Natural frequencies and modes of vibration by classical method, coupled pendulum, forced vibration, dynamic vibration absorber.

UNIT – IV 10 Hrs

Multi Degree Freedom Systems:

Lagrangian method for formulation of equation of motion Influence co- efficient method, Lumpedmass and distributed mass systems, Stodola method, Holzer's method, model analysis of free and forced vibrations.

UNIT – V 8 Hrs

Vibration measurement and Applications

Transducers: variable resistance transducers, Piezoelectric transducers, electro dynamic transducers and linear variable differential transformer transducer; Vibration pickups: vibrometer, accelerometer, velometer and phase distortion; Frequency-measuring instruments; Vibration exciters- Mechanical exciters and electro dynamic shaker.

Course Code	REFRIGERATION AND AIR CONDITIONING		L	T	P	C
20A03702c			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Appraise the importance of humidifiers and dehumidifiers
CO2	Select the requirements of temperature and humidity for human comfort
CO3	Demonstrate the heat pump working and its components
CO4	List the various air conditioning equipments

UNIT – I 10 Hrs

Introduction to Refrigeration

Necessity and Applications, Carnot Refrigerator, First and Second Law Applied to Refrigerating Machines, Unit of Refrigeration, COP, EER, Different Refrigeration Methods.

Air Refrigeration: Bell-Coleman Cycle, Ideal and Actual Cycles, Open and Dense Air Systems - Numerical Problems - Refrigeration Needs of Air Crafts.

UNIT – II 10 Hrs

Vapour Compression Refrigeration (VCR) System

Vapour Compression Refrigeration (VCR) System - Basic Cycle - Working Principle and Essential Components of the Plant - COP - Representation of Cycle On T-S and P-h Charts - Expander Vs. Throttling, Effect of Sub Cooling and Super Heating - Cycle Analysis - Actual Cycle- Influence of Various Parameters on System Performance - Construction and Use of P-h Charts - Numerical Problems. Refrigerants - Desirable Properties - Classification of Refrigerants Used - Nomenclature- Secondary Refrigerants- Lubricants - Ozone Depletion - Global Warming-

Newer Refrigerants.

UNIT – III 8 Hrs

Vapor Absorption Refrigeration (VAR) System

Vapor Absorption Refrigeration (VAR) System-Description and Working of NH_3 - Water System and Li Br -Water (Two Shell & Four Shell) System -Calculation of Max COP, Principle of Operation of Three Fluid Absorption System

STEAM JET REFRIGERATION SYSTEM: Working Principle and Basic Components-Estimation of Motive Steam Required Principle and Operation of: (I) Thermo-Electric Refrigerator (ii) Vortex Tube or Hilsch Tube.

UNIT – IV 10 Hrs

Introduction to Air Conditioning:

Psychrometric Properties & Processes - Characterization of Sensible and Latent Heat Loads - Need For Ventilation, Consideration of Infiltrated Air - Heat Load Concepts. Air Cooler (Evaporative Cooling) ,Window, Split, Summer , Winter, Year Round, Central Air Conditioning Systems.

UNIT – V 8 Hrs

Air Conditioning Equipment

Air Conditioning Equipment - Humidifiers - Dehumidifiers - Air Filters, Fans and Blowers.

Human Comfort**:** Requirements of Temperature, Humidity And Concept of Effective Temperature, Comfort Chart. Heat Pump - Heat Sources - Different Heat Pump Circuits.

Course Code	**MECHATRONICS AND MEMS**		**L**	**T**	**P**	**C**
20A03703a			**3**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Semester**	**VI**			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Demonstrate the knowledge of MEMS
CO2	Classifying different fabrication techniques of MEMS
CO3	Illustrate the application of MEMS in industry

UNIT – I 10 Hrs

Introduction

Definition of Mechatronics, Need for Mechatronics in Industry, Objectives of mechatronics, mechatronics design process, Mechatronics key elements, mechatronics applications – Computer numerical control (CNC) machines, Tool monitoring systems, Flexible manufacturing system (FMS), Industrial Robots, Automatic packaging systems, Automatic inspection systems.

UNIT – II 10 Hrs

Sensors

Static and dynamic characteristics of sensors, Displacement, Position and Proximity sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors.

UNIT – III 8 Hrs

Actuators

Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems, Characteristics and their limitations, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys, Selection criteria for actuators.

UNIT – IV 10 Hrs

Microprocessors, Microcontrollers and Programmable Logic Controllers

Architecture of Microprocessor, Microcontroller and Programmable Logic Controller, PLC Programming using ladder diagrams, logics, latching, sequencing, timers relays and counters, data handling, Analog input/output, selection of controllers.

UNIT – V 8 Hrs

Micro Electro Mechanical Systems (MEMS)

History, Effect of scaling, Fabrication Techniques: Oxidation, Physical Vapor disposition, Chemical Vapor Deposition, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip.

Course Code	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS		L	T	P	C
20A03703b			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Compare the differences between hydraulic and pneumatic systems
CO2	Identify the practical applications in automation
CO3	Build the circuits for a given applications
CO4	Develop hydraulic and pneumatic power packs
CO5	Discuss the importance of PLC and microprocessor in hydraulic and pneumatic systems

UNIT – I 10 Hrs

Introduction

Introduction to fluid power - Types, advantages and application of fluid power systems. Properties of hydraulic fluids – General types of fluids – Fluid power symbols as per ISO/ANSI. Basic Components of Hydraulic and Pneumatic Systems. Comparison of Mechanical, Electrical, Hydraulic & Pneumatic systems for force and motion analysis in automation.

UNIT – II 10 Hrs

Hydraulic Pumps, Actuators: Types of hydraulic pumps - construction and working principle - design considerations, selection, specifications and characteristics of pumps. Types of actuators- construction and working principle - design considerations, selection, specifications and characteristics of actuators.

Control And Regulation Elements: Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses. Selection of valves for hydraulic circuits.

UNIT – III 8 Hrs

Design Of Hydraulic Circuits

Speed control circuits - Regenerative circuits- Accumulators and Intensifiers: Types of accumulators Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier–Intensifier circuit. - Reservoir design - Selection of components. Hydraulic circuits - Reciprocating - Quick return - Sequencing synchronizing - Safety circuits - Industrial circuits - Press - Milling Machine - Planner - Fork Lift.

UNIT – IV 10 Hrs

Pneumatic Systems

Pneumatic fundamentals - Properties of air – Compressors – Filter, Regulator, and Lubricator

unit – Air control valves, Quick exhaust valves, and pneumatic actuators. Control Elements - Logic Circuits -Position - Pressure Sensing - Switching – Electro Pneumatic - Electro Hydraulic Circuits - Robotic Circuits.

UNIT – V 8 Hrs

Design Of Pneumatic Circuits

Classic-Cascade-Step counter - Combination -Methods - PLC-Microprocessors -Uses - Selection criteria for Pneumatic components - Installation and Maintenance of Hydraulic and Pneumatic power packs - Fault finding - Principles of Low Cost Automation - Case studies.

Course Code	GEOMETRIC DIMENSIONING AND TOLERANCES		L	T	P	C
20A03703c			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	This course systematically introduces the essentials of the language of geometric dimensioning and tolerancing (GD&T) based on ASME standards, as well as the essentials of surface roughness measurements in both 2D and 3D including filtering techniques.
CO2	This course also introduces the related concepts of Vectorial dimensioning and tolerancing, dimensional chains, measurement uncertainty, etc.
CO3	The knowledge gained by the students by learning the above topics will help them to performvery well in their profession as metrologists as well as product designers.

UNIT – I 10 Hrs

Basic Concepts

General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Inspection of dimensional and geometrical deviations - Datums, datum systems, and selection of datums. Restraining degrees of freedom, DOF, Simulators. Rule #1(Boundary principle) and Rule #2.

UNIT – II 10 Hrs

Form and Orientation Tolerances

Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T); Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances. Exercises on each group. RFS, MMC and LMC concepts.

UNIT – III 8 Hrs

Location, Runout and Profile Tolerances

Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums - Tolerances of runout - Tolerancing of anglesand cones. Exercises on each group. RFS, MMC and LMC concepts.

UNIT – IV 10 Hrs

Surface Roughness

Various parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters, symbology

UNIT – V 8 Hrs

Inspection of GD&T call-outs

Vectorial dimensioning and tolerancing - Statistical tolerancing of mechanical assemblies - Dimensional chains - Measurement uncertainty - Computer-aided tolerancing and verification. Inspection techniques- conventional and CMM.

Course Code	ENTREPRENEURSHIP & INCUBATION		L	T	P	C
20A52701a			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understand the concept of Entrepreneurship and challenges in the world of competition.
CO2	Apply the Knowledge in generating ideas for New Ventures.
CO3	Analyze various sources of finance and subsidies to entrepreneur/women Entrepreneurs.
CO4	Evaluate the role of central government and state government in promoting Entrepreneurship.
CO5	Create and design business plan structure through incubations.

UNIT – I 10 Hrs

Entrepreneurship - Concept, knowledge and skills requirement - Characteristics of successful entrepreneurs - Entrepreneurship process - Factors impacting emergence of entrepreneurship - Differences between Entrepreneur and Intrapreneur - Understanding individual entrepreneurial mindset and personality - Recent trends in Entrepreneurship.

UNIT – II 10 Hrs

Starting the New Venture - Generating business idea – Sources of new ideas & methods of generating ideas - Opportunity recognition - Feasibility study - Market feasibility, technical/operational feasibility - Financial feasibility - Drawing business plan - Preparing project report - Presenting business plan to investors.

UNIT – III 8 Hrs

Sources of finance - Various sources of Finance available - Long term sources - Short term sources - Institutional Finance – Commercial Banks, SFC's in India - NBFC's in India - their way of financing in India for small and medium business - Entrepreneurship development programs in India - The entrepreneurial journey- Institutions in aid of entrepreneurship development.

UNIT – IV 10 Hrs

Women Entrepreneurship - Entrepreneurship Development and Government - Role of Central Government and State Government in promoting women Entrepreneurship - Introduction to various incentives, subsidies and grants – Export- oriented Units - Fiscal and Tax concessions available - Women entrepreneurship - Role and importance - Growth of women entrepreneurship in India - Issues & Challenges - Entrepreneurial motivations.

UNIT – V 8 Hrs

Fundamentals of Business Incubation - Principles and good practices of business incubation- Process of business incubation and the business incubator and how they operate and influence the Type/benefits of incubators - Corporate/educational / institutional incubators - Broader business incubation environment - Pre-Incubation and Post - Incubation process - Idea lab, Business plan structure - Value proposition.

Course Code	MANAGEMENT SCIENCE		L	T	P	C
20A52701b			3	0	0	3
Pre-requisite	Nil	Semester	VI			

Course Outcomes:

At the end of the course, students will have the ability to:

CO1	Understand the concepts & principles of management and designs of organization in apractical world
CO2	Apply the knowledge of Work-study principles & Quality Control techniques in industry
CO3	Analyze the concepts of HRM in Recruitment, Selection and Training & Development.
CO4	Evaluate PERT/CPM Techniques for projects of an enterprise and estimate time & cost ofproject & to analyze the business through SWOT.
CO5	Create Modern technology in management science.

UNIT – I 10 Hrs

INTRODUCTION TO MANAGEMENT

Management - Concept and meaning - Nature-Functions - Management as a Science and Art and both. Schools of Management Thought - Taylor's Scientific Theory-Henry Fayol's principles - Eltan Mayo's Human relations - Systems Theory - **Organisational Designs** - Line organization - Line & Staff Organization - Functional Organization - Matrix Organization - Project Organization - Committee form of Organization - Social responsibilities of Management.

UNIT – II 10 Hrs

OPERATIONS MANAGEMENT

Principles and Types of Plant Layout - Methods of Production (Job, batch and Mass Production), Work Study - Statistical Quality Control- Deming's contribution to Quality. **Material Management** - Objectives - Inventory-Functions - Types, Inventory Techniques - EOQ-ABC Analysis - Purchase Procedure and Stores Management - **Marketing Management** - Concept - Meaning - Nature- Functions of Marketing - Marketing Mix - Channels of Distribution - Advertisement and Sales Promotion - Marketing Strategies based on Product Life Cycle.

UNIT – III 8 Hrs

HUMAN RESOURCES MANAGEMENT (HRM)

HRM - Definition and Meaning – Nature - Managerial and Operative functions - Evolution of HRM - Job Analysis - Human Resource Planning(HRP) - Employee Recruitment-Sources of Recruitment - Employee Selection - Process and Tests in Employee Selection - Employee Training and Development - On-the- job & Off-the-job training methods - Performance Appraisal Concept - Methods of Performance Appraisal – Placement - Employee Induction - Wage and Salary Administration

UNIT – IV 10 Hrs

STRATEGIC & PROJECT MANAGEMENT

Definition& Meaning - Setting of Vision - Mission - Goals - Corporate Planning Process - Environmental Scanning - Steps in Strategy Formulation and Implementation - SWOT Analysis - **Project Management** - Network Analysis - Programme Evaluation and Review Technique (PERT) - Critical Path Method (CPM) Identifying Critical Path - Probability of Completing the project within given time - Project Cost- Analysis - Project Crashing (Simple problems).

UNIT – V 8 Hrs

CONTEMPORARY ISSUES IN MANAGEMENT

The concept of Management Information System(MIS) - Materials Requirement Planning (MRP) - Customer Relations Management(CRM) - Total Quality Management (TQM) - Six Sigma Concept - Supply Chain Management(SCM) - Enterprise Resource Planning (ERP) - Performance Management- Business Process Outsourcing (BPO) - Business Process Re-engineering and Bench Marking - Balanced Score Card - Knowledge Management.

Semester–VII						
S.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1.	20A03701a 20A03701b 20A03701c	**Professional Elective Course– III** Modern manufacturing Methods Design for Manufacturing (DFM) Operations Research	3	0	0	3
2.	20A03702a 20A03702b 20A03702c	**Professional Elective Course– IV** Automobile Engineering Mechanical Vibrations Refrigeration & Air Conditioning	3	0	0	3
3.	20A03703a 20A03703b 20A03703c	**Professional Elective Course– V** Mechatronics & MEMS Design of Oil Hydraulics and Pneumatics Geometric dimensioning and tolerances	3	0	0	3
4.	20A52701a 20A52701b 20A52701c	**Humanities Elective – II** Entrepreneurship and Incubation Management Science Enterprise Resource Planning	3	0	0	3
5.		**Open Elective Course – III**	3	0	0	3
6.		**Open Elective Course – IV**	3	0	0	3
7.	20A03706	**Skill oriented course - V** Industrial Automation	1	0	2	2
8.	20A03707	Evaluation of Industry Internship				3
					Total	**23**

Open Elective Course – III

S.No	CourseCode	Course Name	Offered by the Dept.
1	20A01704	Cost Effective Housing Techniques	CE
2	20A02704	IOT Applications in Electrical Engineering	EEE
3	20A04704	Electronic Sensors	ECE
4	20A05704a	Web Technologies	CSE & Allied /IT
5	20A05704b	VR & AR for Engineers	
6	20A05704c	Software Engineering	
7	20A27704	Human Nutrition	FT
8	20A54702	Numerical Methods for Engineers	Mathematics
9	20A56702	Sensors And Actuators for Engineering Applications	Physics
10	20A51702	Chemistry of Nanomaterials and Applications	Chemistry

Open Elective Course – IV

S.No	CourseCode	Course Name	Offered by the Dept.
1	20A01705	Health, Safety & Environmental management	CE

2	20A02705	Renewable Energy Systems	EEE
3	20A04705	Microcontrollers and Applications	ECE
4	20A05705a	Cyber Security	CSE & Allied /IT
5	20A05705b	Introduction to Full Stack Development	
6	20A05705c	Industrial IoT	
7	20A27705	Waste and Effluent Management	FT
8	20A54703	Number theory & its applications	Mathematics
9	20A56703	Smart Materials and Devices	Physics
10	20A51703	Green Chemistry and Catalysis for Sustainable Environment	Chemistry