VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

SEMESTER-I

Scheme of Teaching and Examinations and Syllabus
M.Tech., Product Design and Manufacturing (UPD)

(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., Product Design and Manufacturing (UPD)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22UPD11	Mathematical methods in Engg	03	00	00	03	50	50	100	3
2	IPCC	22UPD12	Design Automation with IOT	03	02	00	03	50	50	100	4
3	PCC	22UPD13	Finite Element Analysis	03	00	02	03	50	50	100	4
4	PCC	22UPD14	Product Design & Development	02	00	02	03	50	50	100	3
5	PCC	22UPD15	Product Life Cycle Management	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22UPDL17	Product Design Visualization Engg Lab-I	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	BOS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course, AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Semester- I

MATHEMATICAL METHODS IN ENGG. (common to MPT, MPE, MPD, MEM, MPM, MPY, & MSE)			
Course Code	22UPD11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To have an insight into solving Linear Algebraic Equations.
- Learn to use the roots of equations.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods.
- To enable learning concepts of Sampling theory, RBD and their implication in Mechanical Engineering.
- To understand the techniques of Simple mathematical models in estimating high accuracy and their applications.

Module-1

Errors and Simple Mathematical modelling: Error definition, round off errors and truncation errors. Mathematical modelling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering. Engineering Applications on : i) Deflection of Beams ii) Terminal velocity of a freely falling body (RBT Levels: L1 & L2) (Text Book:1) 8 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

System of Linear Algebraic Equations And Eigen Value Problems: Gauss-Jordan Method, Cholesky Method, Partition method, Givens method for symmetric matrices, (RBT Levels: L1 & L2) (Text Book:3) 8Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Roots of Equations: Muller's method, Graeffe's roots squaring method. Numerical solutions of second order ordinary differential equations: Runge Kutta method & Milne's Predictor-corrector method.. (RBT Levels: L2 & L3) (Text Book:3) 8Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Partial Differential Equations: Numerical solution of one dimensional wave equation, Heat equation,(Schmidt`s explicit formula)& Laplace equation(Gauss-Seidel process) by finite difference schemes. (RBT Levels: L2 & L3) (Text Book:6). 8Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Sampling theory: Testing of hypothesis (Single mean & single proportion only), Chi square test and F-test. Analysis of Variance (ANOVA): one way classification, Design of experiments, RBD. (RBT Levels: L2 & L3) (Ref. Book:4). 8Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Ed., cGraw-Hill Edition, 2015
2. Theory of ordinary differential equations, Coddington E., Levinson N., McGraw-Hill publishing Company, TMH Edition, 9th Reprint, 1987..
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
4. R.E, Walpole, R.H.Myres, S.L.Myres and Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson, 2012
5. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999
6. K Shankar Rao, "Introduction to Partial Differential Equations" Prentice - Hall of India Pvt. Lt. , 1995 Edition
7. C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics". 6th edition, McGraw-Hill, 1995.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Acquire the idea of significant figures, types of errors during numerical computation.	L2
CO2	Learn various numerical methods to solve system of linear equations	L2
CO3	Analyze and solve PDE‟s related to wave equation arising in vibration analysis.	L4
CO4	Understand sampling theory	L2
CO5	Acquire knowledge of algebraic equations and analyze	L4

Program Outcome of this course

Sl. No.	Description	Pos
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CO2	**2**	**3**	**2**	**3**	**3**	**2**	**3**
CO3	**3**	**3**	**2**	**3**	**2**	**3**	**3**
CO4	**2**	**3**	**1**	**2**	**3**	**3**	**2**
CO5	**2**	**3**	**3**	**2**	**2**	**3**	**2**

DESIGN AUTOMATION WITH IOT			
Course Code	**22UPD12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

1. To introduce students to the field of IoT
2. To familiarise students' different types of sensors used in automation
3. To provide awareness about the applications of IoT

MODULE-1	
Introduction to IoT & Cyber-Physical Systems, IoT Enabling Technologies– Physical End points, Network Services, Cloud. Different Levels of IoT Applications. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2	
Communication and networking technologies in IoT: Communication models, AdHoc. Industrial & Automotive Networks, Vehicular networks 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3	
Thermo resistive Sensors- Thermistors, Resistance Temperature Sensors, and Silicon Resistive Sensors, Thermo electric sensors, PN junction temperature sensors, thermos mechanical sensors and actuators. Photoelectric sensors, optical actuators. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4	
Mechanical Sensors and Actuators- force sensors, pressure sensors, Acoustic actuators, ultrasonic sensors and actuators. MEMS and Smart sensors- pressure sensors, thermal and piezo electric actuation, wireless sensors and actuators. 08Hrs	
Teaching-Learning Process	Chalk and talk method / Power Point Presentation

MODULE 5	
IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring. Applications HCI and IoT world -Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research Challenges. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Sense the Available Networks Using Arduino / Micro controller 8085
2	Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino / Micro controller 8085

3	Detect the Vibration of an Object Using Arduino / Micro controller 8085
4	Connect with the Available Wi-Fi Using Arduino / Micro controller 8085
5	Sense a Finger When it is Placed on Board Using Arduino / Micro controller 8085
6	Temperature Notification Using Arduino / Micro controller 8085
7	LDR to Vary the Light Intensity of LED Using Arduino / Micro controller 8085
8	SQL Queries by Fetching Data from Database in Raspberry Pi
9	Switch Light On and Off Based on the Input of User Using Raspberry Pi

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will

have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013

2. Vijay Madisetti and Arshdeep Bahga,"Internet of Things (A Hands-on-Approach)",1st Edition,VPT, 2014.

3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

4. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',YoleDéveloppement Copyrights ,2014

5. Jacob Fraden, (2010), Handbook of Modern Sensors, 5th Edition, Springer.

6. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David

7. Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Ageo Intelligence" Elsevier

Web links and Video Lectures (e-Resources):

- https://youtu.be/urUBLmXFKl0
- https://youtu.be/A4CHQ_lb4rY
- https://youtu.be/r_Job1rEbT0
- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand concepts of IOT	L2
CO2	Knowledge of Various sensors for IoT	L2
CO3	Apply IoT to different applications	L3

Program Outcome of this course

Sl. No.	Description	Pos
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos (indicative only)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**1**	**1**	**2**	**3**	**3**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**3**
CO3	**1**	**2**	**2**	**3**	**2**	**3**	**3**

Note : High - 1, Medium – 2, and Low – 3

FINITE ELEMENT ANALYSIS			
Course Code	**22UPD13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + (10-12) Activity	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- Understand the mathematical principles behind the Finite Element Method: A numeric strategy to solve partial differential equations (PDEs).
- Understand concepts for solving truss structures and continuum structures.
- Use the commercially available software like ANSYS.

MODULE-1	
Introduction: Equations of equilibrium, stress-strain relations for 2-D and 3-D, Potential energy and equilibrium, Boundary conditions, Von Misses Stresses. FEM for 1-D Problems: General procedure for FEA, Raleigh Ritz method, Galerkin Approach, shape functions, stiffness matrix, load vectors, temperature effects, Applications of boundary conditions using elimination and penalty approaches. 10Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
MODULE-2	
FEM for 1 D and 2-D Problems: Application problems – 1-D bar element. Trusses and beams, Shape functions (2D element), stiffness matrix, strain matrix, load vectors for CST Elements and application problems. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
MODULE-3	
FEM for Axisymmetric Problems: Axisymmetric formulation, triangular elements, PE approach, Body force term, application problems. 06Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
MODULE-4	
FEM for Scalar Field Problems: 1-D Steady state heat transfer, torsion, and application Problems . 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
MODULE 5	
Dynamic Analysis: Equations of motion for dynamic problems consistent and lumped mass matrices formulation of element mass matrices free vibration and forced vibration problems formulation. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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CIE for the theory component of IPCC

- Two Tests each of **20 Marks**
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CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

- Introduction to Finite Elements in Engineering – Tirupathi R.- Chandrupatla Ashok DBelegundu -Prentice Hall India Pvt. Ltd., New Delhi – 3rd Edition, 2003
- Concepts and Applications of finite Element Analysis - Cook R.D - Malkus D.S &PleshaM.E – JohnWiley& Sons - 1989.
- Applied Finite Element Analysis -Segerlind L.J - John Wiley & Sons Edition-1984
- The Finite Element Method in Engineering, - Rao SS Pergomon Press – Oxford –
- Finite Element Procedures in Engineering Analysis - Bathe K .J - Prentice Hall NewJersey- 1982.
- Energy and Finite Element Methods in Structural mechanics - Shames III &DymC L -Wiley eastern ltd– 1995.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program
- **https://youtu.be/UOp6JEiJctA**
- **https://youtu.be/NYiZQszx9cQ**

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

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Solve differential equations using weighted residual methods	L3
CO2	Develop the finite element equations to model engineering problems governed by second order differential equations	L5
CO3	Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements	L3
CO4	Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system	L3

Program Outcome of this course

Sl. No.	Description	Pos
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos (indicative only)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	3	3	3	3
CO2	2	1	2	2	2	3	3
CO3	1	2	1	3	2	3	2
CO4	1	2	1	3	2	3	2

Note : High - 1, Medium – 2, and Low – 3

PRODUCT DESIGN AND DEVELOPMENT

Course Code	22UPD14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 theory + 10-12 activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To study the modern product development processes.
- To Understand and explain the concept of Industrial design and robust design concepts.
- To know the concept of Design for manufacture and assembly.
- To Understand the legal factors, social issues, engineering ethics related to product design

Module-1

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. **Development Processes and Organizations**: A generic development process, concept development: the front-end process, adopting the generic product development process, 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. **Identifying Customer Needs**: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications. **Concept Generation**: The activity of concept generation, clarifies the problem, search externally, search internally, explore systematically, and reflect on the results and the process. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Concept Selection: Overview of methodology, concept screening, and concept scoring, Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process. 04Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, 06Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **oneSkill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003
- New Product Development - Timjones. Butterworth Heinmann - Oxford. UCI -1997
- Product Design for Manufacture and Assembly - GeofferyBoothroyd, Peter Dewhurst and Winston Knight - 2002
- Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program
- https://youtu.be/HN9GtL21rb4

Activity (Note – Suitable activities may also be added, the given are indicative only)

- Study and Develop the AMF Process in the product design, Product development organization
- Design a Product taking consideration of Ergonomics
- Study the design for manufacturing process and determine manufacturing cost for a particular product and identify the areas of cost reductions based on DFM guidelines.
- To study the industrial design process and assessing method the quality of industrial design in new product.
- To study the product the development economics and understand the elements of economic analysis.
- Study the principal of prototyping and its technologies also the planning for prototypes
- To study and identify the qualitative factors on project success by taking case study and perform the qualitative analysis.
- To study and understand the method the managing the projects and representing the task, baseline project planning along with method of execution and execution of project

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product life cycle	L2
CO2	Undertake a methodical approach to the management of product development to satisfy customer needs.	L3
CO3	Identify and analyse the product design and development processes in manufacturing industry	L4
C04	Analyse, evaluate and apply the methodologies for product design, development and management.	L4
C05	Carry out cost and benefit analysis through various cost models	L4

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and POs (indicative only)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**3**	**2**	**2**	**3**
CO2	**2**	**3**	**2**	**2**	**3**	**3**	**2**
CO3	**2**	**3**	**1**	**1**	**2**	**3**	**2**
CO4	**3**	**2**	**3**	**2**	**2**	**1**	**3**
CO5	**1**	**2**	**2**	**2**	**1**	**3**	**3**

Note : High - 1, Medium – 2, and Low – 3

PRODUCT LIFE CYCLE MANAGEMENT			
Course Code	22UPD15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 theory + 10-12 activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

(a) To integrate systematic approaches of innovative product development methods governed by design thinking with an awareness of business considerations needed to produce products with superior quality.

(b) To develop ability to employ state-of-the-art technology in product and process development and be PLM proficient.

(c) To develop skills to support product realization, including communications, technical writing, and customer needs analysis.

(d) To learn independently and continuously as a lifelong learner, and to work effectively in a global team environment.

(e) To develop awareness of professional ethics and social responsibilities and the methods necessary to achieve quality.

Module-1	
Product life cycle management: Need for PLM, Components of PLM, Product Data and Product workflow. 05 Hrs,	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
The PLM Strategy, Developing a PLM Strategy, A Five-step Process, Strategy Identification and Selection, Strategy Elements, Implications of Strategy Elements, Policies, Strategy Analysis, Communicating the Strategy 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Change Management for PLM, Configuration management, Cost of design changes, schemes for concurrent engineering. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Modeling, Current concepts, Standards for Engineering data exchange. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Tolerance mass property calculations, rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques, 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **One Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Product Lifecycle Management Paradigm for century Product Realization - John Stark, Springer-Verlag, 21st, London, 3rd printing - 2006. 441 pp., ISBN: 1-85233-810-5.
- CAD/CAM Theory and Practice - Zeid, McGraw Hill.- 1991.
- Computer Integrated Design and Manufacturing, - Mark Henderson & Philip Wolfe, Bedworth McGraw hill inc.- 1991.
- Part modeling Users Guide, Engineer - I998.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Activities (suggested activities/ SDA or any other appropriate activity may be given and evaluated)

- Study and implement the Design failure and Effect analysis on the new product
- Apply the Design for manufacturing and assembly on product life cycle process
- Create a part design by sketching and showcase the datum constructions,
- Create an appropriate part having geometric tolerance for particular application.
- Study the steps in Finite element analysis to apply to solve a problem using FEM
- Perform static analysis on a structural element as a case study.
- Create a 3D model of the component and perform tolerance and mass property calculations.

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.	L2
CO2	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan	L2
CO3	Demonstrate various approaches and techniques for designing and developing products.	L3
C04	Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc	L3
Co5	Illustrate the Tolerance mass property calculations.	L3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos (indicative only)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**2**	**3**	**2**	**3**	**2**	**2**	**3**
CO2	**2**	**3**	**2**	**2**	**3**	**3**	**2**
CO3	**2**	**2**	**1**	**2**	**3**	**2**	**3**
CO4	**2**	**3**	**2**	**2**	**1**	**1**	**2**
CO5	**3**	**2**	**3**	**1**	**2**	**3**	**2**

Note : High - 1, Medium – 2, and Low – 3

RESEARCH METHODOLOGY AND IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers‟ Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation(WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules,Patents,Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the RightHolder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.10Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

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2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.
- Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.
- Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September2013.
- Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
- Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	L3
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L3
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	L3
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR	L3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	
PO4	Understand contemporary issues in manufacturing engineering and develop relationship between product design and manufacturability to create safe, reliable, and cost-effective products.	
PO5	Understand the process of converting customer needs into engineering specifications to create product designs that are sensitive to user needs and robust against unanticipated uses and misuse	
PO6	Employ advanced prototyping methods to shorten design cycles and narrow alternatives without restricting innovation.	
PO7	Understand and debate the roles and responsibilities of a product designer/manufacturer on society.	

Mapping of COS and Pos (indicative only)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1							
CO2							
CO3							
CO4							
CO5							

Note : High - 1, Medium – 2, and Low – 3

PRODUCT DESIGN VISUALIZATION ENGG LAB-I			
Course Code	22UPDL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	100

Course objectives:

1. To learn basic principles of finite element analysis procedure .
2. To learn the theory and characteristics of finite elements that represent engineering structures.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses

Sl.NO	Experiments
1	Static (Structural) Analysis of 1-D problems
2	Static (Structural) Analysis of plane stress and Plane Strain Problems
3	Structural Analysis of Trusses
4	Static Analysis of Axis Symmetric problems
5	Transient Heat Transfer Analysis of 1D problems
6	Transient Heat Transfer Analysis of 2D problems
7	Heat Transfer Analysis of Axis Symmetric Problems
8	Dynamic Analysis of 1D problems – Free vibration Analysis
9	Non-linear Static Analysis – Typical problems in geometric and material non-linear Analysis
10	Buckling Analysis of Shell Structures

Course outcomes (Course Skill Set):

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

- Solve basic problems using finite element methods
- Perform structural and dynamic problems using finite element methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is 50 Marks.

The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to 20 marks (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course is 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours

Suggested Learning Resources:

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Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.