VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Product Design and Manufacturing (MPD)
(Effective from the Academic year 2022-23)

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Programme Outcome:

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.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., Product Design and Manufacturing (MPD) (Font 09 Capital, Calibri)
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	22MPD/MTE/MST /MEM/MPM/MPY/MSE11	Mathematical methods in Engg	03	00	00	03	50	50	100	3
2	IPCC	22MPD12	Design Automation with IOT	03	02	00	03	50	50	100	4
3	PCC	22MPD13	Finite Element Analysis	03	00	02	03	50	50	100	4
4	PCC	22MPD14	Product Design & Development	02	00	02	03	50	50	100	3
5	PCC	22MPD15	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	22MPDL17	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)

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.

Semester- I

Semester- I

MATHEMATICAL METHODS IN ENGG. (common to MPD/MTE/MST/MEM/MPM/MPY/MSE)			
Course Code	22MPD11	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 modeling 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.	
CO2	Learn various numerical methods to solve system of linear equations	
CO3	Analyze and solve PDE‟s related to wave equation arising in vibration analysis.	
CO4	Understand sampling theory	
CO5	Acquire knowledge of algebraic equations and analyze	

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	**22MPD12**	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):

- 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	
CO2	Knowledge of Various sensors for IoT	
CO3	Apply IoT to different applications	

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	**22MPD13**	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**
- Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

- 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

- 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

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	
CO2	Develop the finite element equations to model engineering problems governed by second order differential equations	
CO3	Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements	
CO4	Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system	

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	22MPD14	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

Activity (Note – Suitable activities may also be added)

- 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	
CO2	Undertake a methodical approach to the management of product development to satisfy customer needs.	
CO3	Identify and analyse the product design and development processes in manufacturing industry	
C04	Analyse, evaluate and apply the methodologies for product design, development and management.	
C05	Carry out cost and benefit analysis through various cost models	

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	22MPD15	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.	
CO2	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan	
CO3	Demonstrate various approaches and techniques for designing and developing products.	
C04	Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc	
Co5	Illustrate the Tolerance mass property calculations.	

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)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	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.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
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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

- 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	
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	
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	

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	22MPDL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:1:2:0	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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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Product Design and Manufacturing (MPD)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
JnanaSangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

Programme Outcome:

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.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., Product Design and Manufacturing (MPD) (Font 09 Capital, Calibri)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22MPD21	Design for Manufacturing	02	00	02	03	50	50	100	3
2	IPCC	22MPD/MAU/MPT/ MPY/MPE22	Industrial Design and Ergonomics	03	02	00	03	50	50	100	4
3	PEC	22MPD23x	Professional elective 1	02	00	02	03	50	50	100	3
4	PEC	22MPD24x	Professional elective 2	02	00	02	03	50	50	100	3
5	MPS	22MPD25	Mini Project with Seminar	00	04	02	--	100	--	100	3
6	PCCL	22MPDL26	Product Design Visualization Engg Lab-II	01	02	00	03	50	50	100	02
7	AUD/ AEC	22AUD27	Suggested ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab,
L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

Professional Elective 1		**Professional Elective 2**	
Course Code under 22MPD23X	**Course title**	**Course Code under 22MPD24X**	**Course title**
22MPD231	Material Handling Equipment Design	22MPD241	Sensors for Industrial Application
22MPD/MTE/MCM	Value Engineering	22MPD242	Advanced Manufacturing
22MPD233/MCM234	Metrology and Computer Aided Inspection	22MPD/CAE/MPM243	Composite Materials Technology
22MPD/MSE234	Cloud manufacturing	22MPD244	Computational Fluid Dynamics
22MPD235	Advance Manufacturing Systems	22MPD/MAU/MDE/MEA/MMD/MTP/MPY/MIA/MAR/CAE/MPE/MPM/MCM245	Industry 4.0

Note:
1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.
The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.
2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Semester- II

DESIGN FOR MANUFACTURING			
Course Code	22MPD21	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:

- Understanding the basic rules for design for manufacturing and material selection.
- Applying the guidelines for ease of design, manufacturing and assembly.
- Analyze factors for selection of material and process, relationship to manufacturing processes
- Apply the concepts of design for manufacturing and assembly for product manufacturing.
- Compare various manufacturing processes and assembly techniques required for product development to optimise the process.

Module-1

Material and process selection – Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Selection of materials. Engineering Design features. – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Assembly limits, Datum features.

Component design – Machining Considerations – Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Examples. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Component design – Casting Considerations – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Design for Injection molding and Sheet metal working – Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Design for Die casting and Powder metal processing – Die casting alloys, cycle, machines, dies, finishing,

Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines. 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 Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight
- Designing for Manufacturing – Harry Peck - Pitman Publications – 1983
- Dimensioning and Tolerancing for Quantity Production – Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey - Prentice Hall, 5thedition.

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	Understand the principles of manufacturability and design for manufacture	
CO2	Design casting for economic production.	
CO3	Understand the concept of easy assembly, based on rules of DFMA to reduce the time of assembly.	
CO4	Redesign the parts for easy manufacturing based on rules of DFMA to reduce the time of manufacturing and enhance cost effectiveness.	
CO5	Design guidelines and background for powder metallurgy parts and reviewing of formed parts.	

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	1	2	2	2	3	2	2
CO2	2	3	2	3	2	2	2
CO3	3	2	3	1	2	3	2
CO4	2	3	2	3	3	2	3
CO5	3	2	3	2	3	3	2

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

INDUSTRIAL DESIGN AND ERGONOMICS			
Course Code	**22MPD/MAU/MPT/MPY/MPE22**	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:

- To increase awareness of the need for and role of ergonomics in occupational health.
- To obtain knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
- To understand the breadth and scope of occupational ergonomics.

MODULE-1	
Introduction: An approach to industrial design -elements of design structure for industrial design in engineering application in modern manufacturing systems. Ergonomics and Industrial Design: Introduction -general approach to the man- machine relationship- workstation design-working position. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2	
Control and Displays: Shapes and sizes of various controls and displays-multiple, displays and control situations - design of major controls in automobiles, machine tools etc. Ergonomics and Production: ergonomics and product design - ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design limitations of anthropometric data- use of computerized database. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3	
Visual Effects of Line and Form: The mechanics of seeingpsychology of seeing general influences of line and form. Colour: Colour and light -colour and objects- colour and the eye - colour consistency- colour terms- reactions to colour and colour continuation –colour on engineering equipments. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4	
Aesthetic Concepts: Concept of unity- concept of order with variety - concept of purpose style and environment- Aesthetic expressions. Style-components of style- house style, observation style in capital goods, casestudy08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE 5	
Industrial Design in Practice: General design -specifying design equipments- rating the importance of industrial design -industrial design in the design process. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	Development of Ergonomic Chair for various applications (office & Resting)
2	Design the workspace area such that the work efficiency can be enhanced
3	Design a product using athletics and ergonomics which is useful in day to today's life.
4	Apply the ergonomics in improving the existing product and give min 5 improvement in it.
5	Using House of style and giving an idea on the product development.
6	Implement various concepts and develop new product concepts and make a report on it.

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**.

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)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. 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.
4. 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

- Industrial Design for Engineers - Mayall W.H. - London Hiffee books Ltd.-1988.
- Applied Ergonomics Hand Book - Brain Shakel (Edited) - Butterworth scientific. London
- Introduction to Ergonomics - R. C. Bridger - McGraw Hill Publications -1995.
- Human Factor Engineering - Sanders & McCormick - McGraw Hill Publications – 6thedition, 2002.

Web links and Video Lectures (e-Resources):

- 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	Understanding the concepts of Industrial design and man-machine relationship.	
CO2	Design of optimistic display and control devices for various applications.	
CO3	Applying the anthropomorphic data in ergonomic design	
CO4	Understanding the visual effects of lines, form and color on engineering equipments.	
CO5	Choosing appropriate aesthetic aspects for design of industrial machinery and devices	

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	CO1	2	2	3	1	1	2
CO2	CO2	3	2	2	3	1	2
CO3	CO3	3	2	2	3	2	2
CO4	CO4	1	2	3	2	1	1
CO5	CO5	2	2	2	2	1	3

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

Professional Elective-I

MATERIAL HANDLING EQUIPMENT DESIGN			
Course Code	22MPD231	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 provide knowledge on materials handling equipment
- Classifications of material handling equipment
- Material handling evaluations, selections, and continuous improvements

Module-1

Introduction: Elements of Material Handling System, Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Selection of Material Handling Equipment: Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Design of hoisting elements: Welded and roller chains -Hemp and wire ropes -Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments 5 Hrs.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Design of cranes: Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Design of Bucket Elevators: Introduction, Types of Bucket Elevator, Design of Bucket Elevator - loading and bucket arrangements, Cage elevators, shaft way, guides, counter weights. Packaging and storage of bulk materials: Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, 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:

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

- Conveyor Equipment Manufacturer‟s Association, "Belt conveyors for bulk materials" 6th edition,The New CEMA Book
- Rudenko N., "Materials handling equipment ", Elnvee Publishers, 1970
- Ishwar GMulani and Mrs.Madhu I Mulani, "Engineering Science and application design for belt conveyor", Madhu I. Mulani, 2002.
- Spivakovsy A.O. and Dyachkov V.K., "Conveying Machines, Volumes I and II" , MIR Publishers, 1985.
- Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
- Boltzharol, A., "Materials Handling Handbook", The Ronald press company 1958.
- Kulwiac R. A., „Material Handling Hand Book‟, 2nd edition, JohnWilly Publication, NewYork.
- James M. Apple, „Material Handling System Design‟, John-Willlwy and Sons Publication, NewYork

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Activities

- Industrial Visit (Large, Medium, Small scale industry)
- Mini project on live working model/ Problems.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Select appropriate equipment for material handling and understand the basic roles of the different equipment.	
CO2	Apply appropriate techniques for improving existing material handling systems; recognize the importance of safety and applications of optimization techniques to material handling.	

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	2	3	2	3
CO2	3	2	3	3	2	2	3

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

VALUE ENGINEERING			
Course Code	22MPD/MTE/MCM232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To inculcate specialized knowledge and skill in advanced manufacturing processes using the principles and methods of engineering analysis and design.

Module-1

INTRODUCTION TO VALUE ANALYSIS: Definition of Value, Value Analysis, Value Engineering, Value management, Value Analysis versus Value Engineering, Value Analysis versus Traditional cost reduction techniques, Symptoms to apply value analysis, Coaching of Champion concept. TYPE OF VALUES: Reasons for unnecessary cost of product, Peeling cost Onion concept, unsuspected areas responsible for higher cost, Value Analysis Zone, attractive features of value analysis. Meaning of Value, types of value & their effect in cost reduction. 10 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

FUNCTIONAL COST AND ITS EVALUATION: Meaning of Function and Functional cost, Rules for functional definition, Types of functions, primary and secondary functions using verb and Noun, Function evaluation process, Methods of function evaluation. Evaluation of function by comparison, Evaluation of Interacting functions, Evaluation of function from available data, matrix technique, MISS technique, Numerical evaluation of functional relationships and case studies. PROBLEM SETTING & SOLVING SYSTEM: A problem solvable stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

VALUE ENGINEERING JOB PLAN: Meaning and Importance of Value Engineering Job plan. Phases of job plan proposed by different value engineering experts, Information phase, Analysis phase, Creative phase, Judgement phase, Development planning phase, and case studies. Cost reduction programs, criteria for cost reduction program, Value analysis change proposal.

10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

VALUE ENGINEERING TECHNIQUES: Result Accelerators or New Value Engineering Techniques, Listing, Role of techniques in Value Engineering, Details with Case examples for each of the Techniques. ADVANCED VALUE ANALYSIS TECHNIQUES: Functional analysis system technique and case studies, Value analysis of Management practice (VAMP), steps involved in VAMP, application of VAMP to Government, University, College, Hospitals, School Problems etc., (service type problems). 10 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

APPLICATION OF VALUE ANALYSIS: Application of Value analysis in the field of Accounting, Appearance Design, Cost reduction, Engineering, manufacturing, Management, Purchasing, Quality Control, Sales, marketing, Material Management Etc., Comparison of approach of Value analysis & other management techniques.

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.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. 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

- Techniquesof Value Analysis and Engineering– Lawrence D. Miles, McGraw – Hill Book Company,2ndEdn.
- Value engineering for Cost Reduction and Product Improvement – M.S. Vittal, Systems Consultancy Services Edn 1993
- Value Management, Value Engineering and Cost Reduction – Edward D Heller Addison Wesley Publishing Company 1971
- Value Analysis for Better Management – Warren J Ridge American Management Association Edn 1969
- Getting More at Less Cost (The Value Engineering Way) – G.Jagannathan Tata Mcgraw Hill Pub. Comp. Edn 1995
- Value Engineering – Arther E Mudge McGraw Hill Book Comp. Edn 1981

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Activities

- Mini project on live working model/ Problems.
- Seminar
- Assignment

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To understand the concepts of value engineering, identify the advantages, applications.	
CO2	To understand various phases of value engineering. Analyze the function, its approach and evaluation.	
CO3	To learn queuing theory	
CO4	To evaluate the value engineering operation in maintenance and repair activities. Learning	
CO5	To create the value engineering team and discuss the value engineering case studies.	

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**	**2**	**3**	**3**	**3**
CO2	**3**	**2**	**2**	**2**	**3**	**2**	**3**
CO3	**2**	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**3**	**2**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**2**	**2**	**2**	**2**

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

METROLOGY AND COMPUTER AIDED INSPECTION			
Course Code	22MPD233/MCM234	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 learn various concepts of instrumentation, metrology & computer assisted inspection.
- To have practical view of various measuring, gauging instruments.

Module-1

Significance of Measurement and Instrumentation: Introduction; generalized configuration and functional stages of measuring systems. The transducer and its environment; an overview; sensing process and physical laws. Types of measurement problems, Characteristics of instruments, design and selection of components of a measuring system. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Errors in Measurement and its Analysis: Causes and types of experimental errors; systematic and random errors. Uncertainty analysis; Transducers and Transduction Principles: Developments in sensors, detectors and transducer technology; displacement transducers; force, torque and motion sensors; piezoelectric transducers; capacitive type transducers; Strain gage transducers; accelerometers, pressure transducers based on elastic effect of volume and connecting tubing. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Metrology and Techniques: Standards in metrology-definition, Traceability, Characteristics Length & Angular measurements Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis

05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Standards for length measurement standards and their calibration: Light interference - Method of coincidence Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, Online and in-process measurements of diameter, Roundness and surface roughness using LASER, straightness and flatness measurement.

Special Measuring Instruments and Techniques:, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques,. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Sensors in Inspection: Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches.

Computer Aided Metrology : Principles and interfacing, soft metrology -Application of lasers in precision measurements- laser interface, laser scanners, Coordinate measurement machine (CMM),

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:

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

- Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e
- Engineering Metrology G. Thomas and G. Butter Worth PUB
- Sensors and Control systems in Manufacturing Sabne Soloman McGraw Hill Book
- Measurement systems: Applications & Design Doebelin International Student Edition
- Optoelectronics for Technology and Engineering Robert G. Seippel Prentice Hall India
- Interface Technology for Computer Controlled Ulrich-Rembold, Armbruster Marcel Dekker Publications, Manufacturing processes and Ulzmann NY
- Study manual on tolerance stacks, vol.1 Second edition ASME. 1994
- Dimensioning and tolerancing of mass Spotts Prentice Hall, 1983

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Mini Project
- 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	The students will gain an experience in the implementation of measuring & gauging techniques.	
CO2	The student will have knowledge on measuring instruments	
CO3	Helps the students to understand the concept of sensors.	

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	3	2	2	2	3	2
CO2	3	2	3	3	2	3	3
CO3	3	3	2	1	1	2	2

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

Professional Elective-3			
CLOUD MANUFACTURING			
Course Code	22MPD/MSE234	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:

- This course will provide an insight into the application of cloud computing in manufacturing enabling high level integration of product development phases.
- It gives an idea about different tools and methodologies used for cloud based product management .

Module-1	
cloud based manufacturing systems- Introduction to cloud computing – definition- architecture of cloud manufacturing-resouce requirements – service oriented manufacturing environment – IaaS, SaaS, PaaS, interoperability of systems, cloud based systems and interoperability – virtual service layer 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Distributed service – definition – application of manufacturing ,assembly processes and management of products for recycling of e-waste – customizable decision making model. Development of cloud community for small and medium industries 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
integrating OEMs and suppliers, out sourcing machining process – Cloud based manufacturing of parts, Vendor selection and supply chain management in cloud environment 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Factors affecting cloud technology adoption and implementation – Benefits of cloud, Barriors and approaches of cloud adoption, various perspectives of users, developers and market teams, Data as a service, Buisness process as a service. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Sustainable manufacturing system, product design, manufacturing – Needs of sustainability - adaption of sustainability factors in product development- manufacturing requirement, strategy, domain for production paradigm, Re use, Recycle, Remanufacture for sustainability- Lifecycle sustainable information management 08Hrs	
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:

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

Suggested Learning Resources:

Books

- Weidong Li , Jorn Mehnen, 'Cloud Manufacturing Distributed computing technologies for global and sustainable manufacturing , Springer New York
- Stark, J., Product Lifecycle Management - 21st Century Paradigm for Product Realization, Springer-Verlag, London, 2005

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	Understand the concept of cloud based distributed environment for collaborative manufacturing.	
CO2	to apply the cloud concepts in a sustainable and global product development	

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	3	2	3	1	3	2
CO2	3	3	2	3	3	2	3

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

ADVANCED MANUFACTURING SYSTEMS			
Course Code	22MPD235	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:

- The students will be exposed to the fundamental concepts and philosophy of advanced manufacturing.
- The paper will provide an overview of the different aspects and components of an advanced manufacturing system.
- This will serve as a basis for the subjects in the later semesters.

Module-1	
Introduction - evolution of CAD/CAM and CIM - scope of CIM - segments of generic CIM - computers and workstations - an overview of CIM software - product development through CAD and CAE – Geometric and modelling technique overview only. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Automated process planning - general methodology of group technology - code structures variant and generative process planning methods 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
CNC technology - principle of numerical control - types of CNC machines - features of CNC systems - programming techniques - capabilities of a typical NC CAM software. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Robotics and automated assembly- types of robots, and their performance, capabilities, programming method of robots, parts of robots, kinematics of robots (robotic motions)- product design for robotised manufacturing. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Green and Agile manufacturing – introduction – agility through group technology, concept of failure mode effect analysis - JIT,SMED 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:

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

- Flexible Manufacturing Cells and System by William W Luggen, Prentice Hall of Inc New Jersey, 1991
- Flexible Manufacturing system by Reza A Maleki, Prentice Hall of Inc New Jersey, 1991
- Flexible Manufacturing by John E Lenz, marcel Dekker Inc New York ,1989.
- Automation, Production Systems and Computer Integrated Manufacturing by Groover, M.P, Prentice Hall.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Develop FMS using the most appropriate technique.	
CO2	Implement FMS concept in a manufacturing environment	
CO3	Use various types of sensors and actuators in PLC implementations	
CO4	Classify automation equipment and assembly systems into different categories.	

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	3	2	3	3
CO2	3	3	2	3	2	3	2
CO3	3	2	3	3	3	2	3
CO4	3	3	2	3	3	2	3

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

Professional Elective-2			
SENSORS FOR INDUSTRIAL APPLICATIONS			
Course Code	22MPD241	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:

- Provides the student with basic knowledge of the industrial automation systems design, installation, modification, maintenance, and repair.
- To study about various sensors and its industrial applications.

Module-1	
Introduction – sensor fundamentals – characteristics – operation principles of different sensors: electrical, optical, acoustic, pneumatic, magnetic, temperature, 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Condition monitoring of manufacturing systems –principles – techniques – selection of sensors – sensors for Monitoring force, pressure, humidity, radiation, temperature, vibration and noise. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Acoustic emission – principles and applications –concepts of pattern recognition - overview 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Sensor network to detect machinery faults – network architecture in manufacturing – Laser sensors 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Automatic identification techniques for shop floor control – bar code scanners – radio frequency identification systems– 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:

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.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Sabrie Soloman, "Sensors: hand book, McGraw Hill
- Jorg Scholz (Editor), "Thermal sensors": Vol. IV, sensors: a comprehensive survey, John Wiley & Sons
- H. H. Bau (Editor), "Mechanical sensors: Vol. VII, sensors: a comprehensive survey", John Wiley & Sons
- Ljubisa Ristia (Editor), "Sensor technology and devices", Artech House Publishers

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Develop an understanding of different types of sensors,	
CO2	Knowledge about their operations and applications	
CO3	Develop an understanding of installation, modification, maintenance, and repair.	
CO4	Explain principles of Steady State Handling Characteristics of Road Vehicles	

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	3	2	1	2	3	2
CO2	3	3	2	3	3	2	2
CO3	2	3	3	2	1	3	2
CO4	3	3	2	3	2	3	3

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

Professional Elective 2			
ADVANCED MANUFACTURING PRACTICES			
Course Code	22MPD242	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 inculcate specialized knowledge and skill in advanced manufacturing processes using the principles and methods of engineering analysis and design.

Module-1

Need of CPC for a company, what CPC can do, CPC-getting the right tool. JIT – Introduction – The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacture, Enabling JIT to occur, Basic elements of JIT, Benefits of JIT. Just in Time Production – Primary purpose, profit through cost reduction, Elimination of over production, Quality control, Quality Assurance, Respect for Humanity, Flexible work Force, JIT Production Adapting to changing production Quantities, process layout for shortened lead Times, Standardization of operation, Automation. Sequence and Scheduling Used by Suppliers: Monthly and daily Information. Sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system tosub contractors. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Toyota Production System-The philosophy of TPS, Basic Frame work of TPS, Kanbans. Determining the Number of Kanbans in Toyota ProductionSystem. a) Kanban Number under Constant Quantity WithdrawalSystem. b) Constant Cycle, Non-constant Quantity WithdrawalSystem. Supplier Kanban and the Sequence Schedule for Use by Suppliers. a) Later Replenishment System byKanban. b) Sequenced WithdrawalSystem. c) Circulation of the Supplier Kanban withinToyota. Production Smoothing in TPS, Production Planning, Production Smoothing, Adaptability to Demand Fluctuations Sequencing Method for the Mixed Model Assembly Line to Realize Smoothed Production of Goal. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Just-in-Time Production with Total Quality Control just in time concept, cutting lot sizes, cutting set-up times, cutting purchase order costs, the JIT cause-Effect chain, Scrap/Quality Improvements, Motivational effects, Responsibility effects, small Group improvement Activities, withdrawal of Buffer Inventory, the total Quality Control Concept

08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Total Quality Control- Introduction-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, Goals, Habit of improvement, perfection, Basics, process control, Easy to see Quality control as facilitator, small lot sizes, Housekeeping, Less than full capacity scheduling, Daily machine checking, Techniquesand Aids, Exposure of problems, Fool proof Devices, Tools ofAnalysis, 29 QC Circles, TQC in Japanese-owned US Electronics plant, TQC in Japanese-ownedAutomotiveplants. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Plant Configurations: Introduction-ultimate Plant configuration, job shop Fabrication, Frame Welding, Forming Frame parts from Tubing, Dedicated production lines, overlapped production, the daily schedule, Forward Linkage by means of Kanban, physical merger of processes, Adjacency, mixed Models, Automated production Lines, Pseudo

Robots, Robots, CAD and Manufacturing, Conveyors and stacker Cranes, Automatic Quality Monitoring.. 08Hrs	
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:

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

Suggested Learning Resources:

Books

- Japanese Manufacturing Techniques - Richard Schonberger - Pearson Higher Education - ISBN:00292910031982
- Just In Time Manufacturing – Kargoanker (manual).
- Wind-chill reference manual
- An Integrated Approach To Just In Time - Yasuhiro Monden - Toyota Production system.
- Lean Thinking - James Womack - Simon & Schuster Adult - ISBN: 0743249275, 2003
- The machine that changed the World - James P. Womack, Daniel T Jones, and Daniel Roos - The story of Lean production – by– Harper Perennial edition published -1991.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explaining the details of types of advanced manufacturing and evolution and need.ϖmachining processes	
CO2	Identifying the correct advanced manufacturing processes by the correct AMPs for development ofϖformulating and determining various complex shapedgeometries.	
CO3	Hands on experiments on the Advanced Machines such as EDM, WEDM etc	
CO4	Design and development of experimental apparatus of any one hybrid manufacturing.ϖadvanced or derived	
CO5	Understand the different Plant configuration	

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**	**3**	**3**	**2**	**3**	**3**
CO2	**3**	**3**	**2**	**1**	**2**	**3**	**2**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**
CO4	**2**	**3**	**3**	**3**	**2**	**2**	**3**
CO5	**3**	**3**	**2**	**3**	**3**	**2**	**3**

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

Professional Elective-2			
COMPOSITE MATERIALS TECHNOLOGY			
Course Code	22MPD/CAE/MPM243	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:

- Provides the student with basic knowledge of the industrial automation systems design, installation, modification, maintenance, and repair.
- To study about various sensors and its industrial applications.

Module-1	
Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Hooke's law for two-dimensional angle lamina, engineering constants - 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths. Failure Criteria: Failure criteria for an elementary composite layer or Ply, 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Manufacturing: Layup and curing - open and closed mould processing, Hand lay- up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. 05 Hrs	
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.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Shivanandam, Deepa S. N Principles of Soft computing Wiley India 2011
- S.R. Jang, C.T. Sun, E. Mizutani Neuro-fuzzy and soft computing Phi (EEE edition), 2012

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the use of fibre-reinforced composites in structural applications.	
CO2	Develop a basic understanding of the use of composite materials ,micro- mechanics of layered composites ,analysis and design of composite structures and failure analysis of laminated panels	
CO3	Apply the basic micro-mechanics theories in the design of fibre reinforced composites.	

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	1	2	3	2
CO2	3	3	2	1	2	3	2
CO3	3	3	2	3	2	2	3

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

Professional Elective-2			
COMPUTATIONAL FLUID DYNAMICS			
Course Code	22MPD244	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:

- Study the governing equations of fluid dynamics Learn how to formulate and solve Euler's equation of motion.
- Become skilled at Representation of Functions on Computer
- Solve computational problems related to fluid flows

Module-1	
Introduction to CFD and Governing Equations Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
One-dimensional Euler's equation Conservative, Non-conservative form and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagona lize 'A'. Eigen values and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Representation of Functions on Computer Need for representation of functions, Box Function, Hat Function, and Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Finite difference method – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations. Explicit methods and Implicit methods – as applied to applied to linear convection equation, Laplace equations, convection-diffusion equation◦ FTCS,FTFS,FTBS,CTCS 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Finite volume method. Finding the flux at interface. Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method Upwind Method in Finite Volume methods . 5Hrs	
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

- T.j.chung Computational Fluid Dynamics Cambridge University Press
- Ghoshdastidar Computational fluid dynamics and heat transfer Cengage learning 2017
- Charles Hirsch Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 & Vol 2 Butterworth- Heinemann 2007
- SuhasPatankarNumerical Heat Transfer and Fluid Flow Taylor and Francis Publisher
- Moin, p Fundamentals of engineering numerical analysis Cambridge university press, , ISBN 9780521805261 2nd ed, 2010
- Ferziger, j. H Numerical methods for engineering application Wiley 2nd ed, 1998

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand mathematical characteristics of partial differential equations	
CO2	Explain how to classify and computationally solve Euler and Navier-Stokes equations.	
CO3	Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.	
CO4	Identify and implement numerical techniques for space and time integration of partial differential equations.	
CO5	Conduct numerical experiments and carry out data analysis.	

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	3	1	2	3	2
CO2	3	3	2	3	2	3	2
CO3	3	2	2	3	2	3	3
CO4	3	3	2	3	3	2	3
CO5	3	2	2	3	2	3	2

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

Professional Elective-2			
INDUSTRY 4.0			
Course Code	22MPD/MAU/MDE/MEA/MMD/MTP/MPY/MIA/MAR/CAE/MPE/MPM/MCM245	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 impart basic idea in Industry 4.0.
- To provide students with good depth of knowledge of designing Industrial 4.0 Systems for various application
- Learn the concepts of Robotics and Augmented Reality

Module-1	
Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Technology Roadmap for Industry 4.0 : Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots-Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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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.

Semester End Examination:

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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

- Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
- Bartodziej, Christoph Jan,"The Concept Industry 4.0".
- Klaus Schwab,"The Fourth Industrial Revolution".
- Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe Industry 4.0 and scope for Indian Industry	
CO2	Demonstrate conceptual framework and road map of Industry 4.0	
CO3	Describe Robotic technology and Augmented reality for Industry 4.0	
CO4	Demonstrate obstacle and framework conditions for Industry 4.0	

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	
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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	3	2	3	2	3	3
CO2	2	3	3	2	3	3	3
CO3	3	3	2	3	2	3	3
CO4	3	2	2	3	2	3	3

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

MINI PROJECT WITH SEMINAR			
Course Code	**22MPD25**	CIE Marks	100
Number of contact Hours/Week	**0-4-2**	SEE Marks	--
Credits	**03**	Exam Hours/Batch	--

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project with seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question-and-Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester.

There is **no SEE** for this course.

Course outcomes:

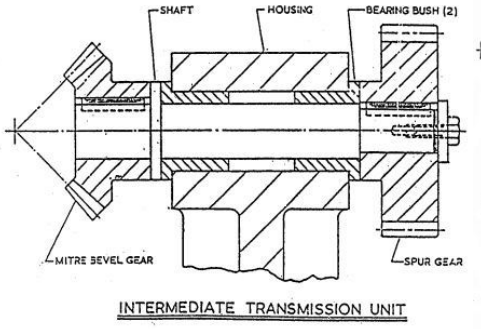
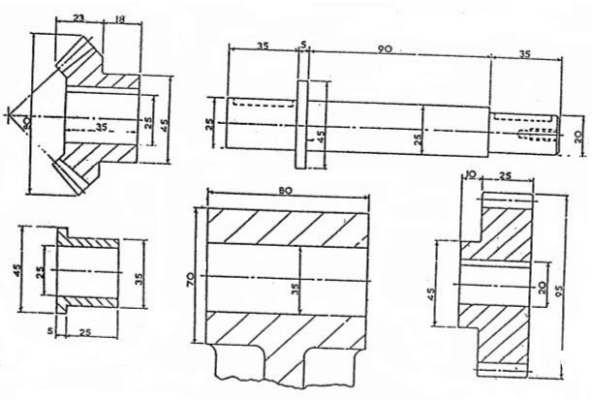
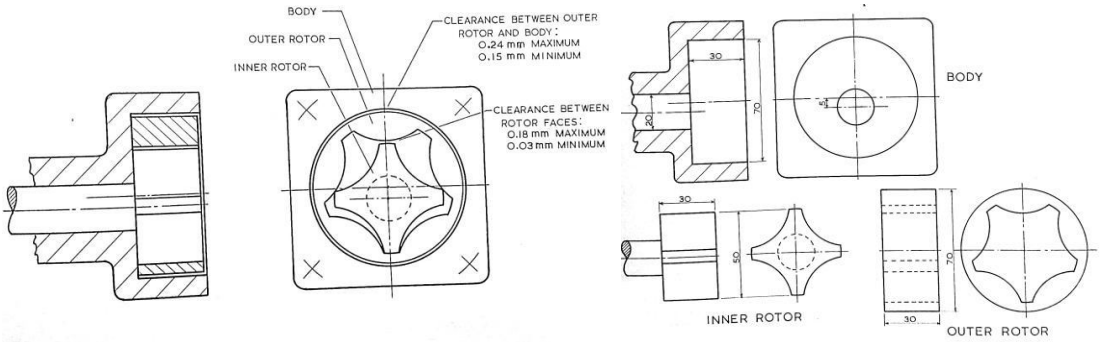
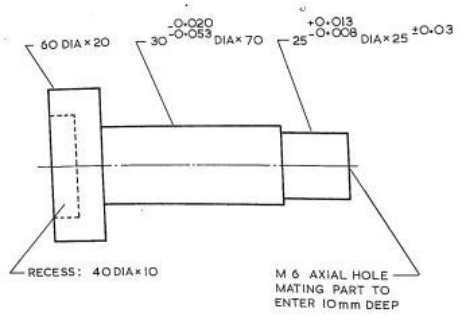
At the end of the course the student will be able to:

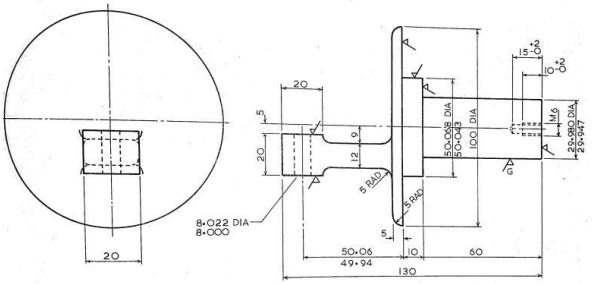
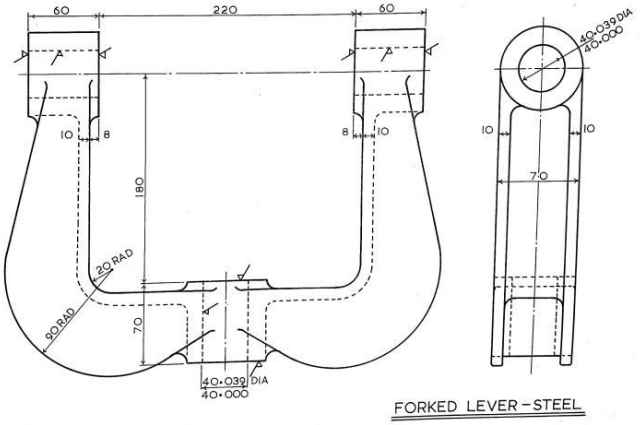
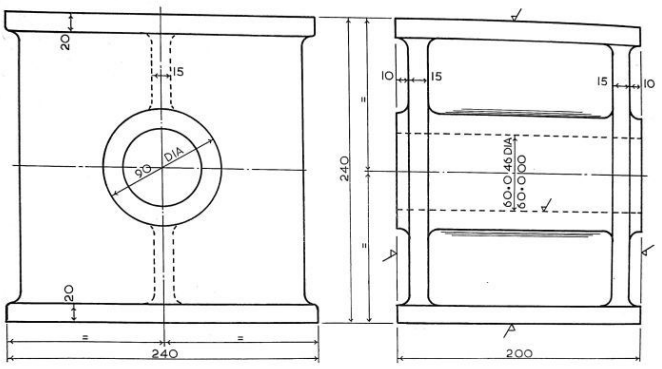
- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

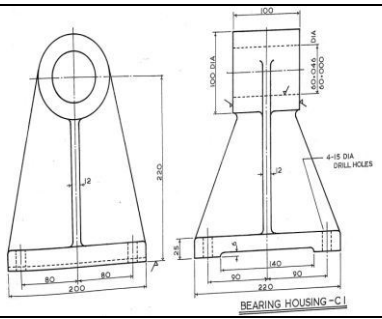
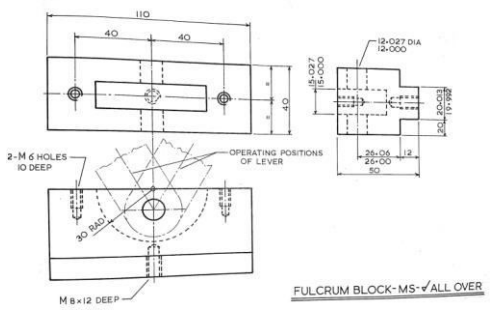
PRODUCT DESIGN VISUALIZATION ENGG LAB-II			
Course Code	22MPDL26	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:1:2:0	SEE Marks	50
Credits	02	Exam Hours	100

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	The shaft assembly of the intermediate transmission unit shown in Fig.1(a) is required to have an axial freedom of maximum 0.18 mm and minimum 0.06 mm when assembled in working condition. Using the nominal sizes specified for the meter bevel gear, shaft, housing, bearing bushes and spur gear, shown in Fig. 1 (b), draw only the relevant components and state only the appropriate limits to achieve the required axial freedom  Figure 1(a) Shaft assembling specified axial freedom  Figure 1 (b) component nominal size
2	The partial assembly of an oil pump is shown in Fig.1.45. A four lobe inner rotor is mounted offset to the body bore in which a five lobe outer rotor rotates, driven by the innerrotor. Both the specified clearances are to be measured by a feeler gauge when the parts are assembled. Taking this procedure into account, and also the fact that the outer rotor can "float" radially, state the appropriate limits for the relevant dimensions which will ensure that the specified clearance limits are not exceeded. Assume zero clearance between inner rotor stem and body bore (20 mm diameter). Nominal sizes are shown inFig.1.46. 
3	The shaft is to be manufactured from 0.4 % carbon steel to the sizes shown in Fig. 2.31. The 30 mm and the 25 mm diameter are to be ground. Prepare a production detail drawing for the shaft. 

4	A suitable sequence for operation the stub carrier shown in Fig.4.40 and redraw the component incorporating features to facilitate manufacture. The carrier is to be produced from a steel casting and the symbol „G" indicates a ground surface for the 30 mm diameter limits  STUB CARRIER-STEEL CASTING
5	Indicate the parting line for the steel forked lever casting seen inFig.5.27, and also the necessary sand cores. Maintaining as nearly as possible, the existing weight of the casting, offer a design modification that will alleviate the sand core requirements.  FORKED LEVER – STEEL
6	For the pedestal shown inFig.5.28 indicate the probable parting line and any unnecessary sand cores, accepting that the probable parting line is the one involving the minimum sand cores. Show a design modification to reduce or eliminate the need for sand cores; maintain approximately same weight of casting in the modified design.  PEDESTAL HOUSING - CAST IRON
7	A bearing bracket, shown in figure 5.32, can have two possible parting lines, each requiring the same sand cores. Indicate each of these parting lines, and the sand cores, and comment on an undesirable casting features involved.
8	A cast iron bearing bracket is shown in figure 5.26. Indicate the preferred parting line and any necessary sand cores. Offer a design modification that will reduce or eliminate the need for sand cores.

	
9	In the fulcrum block, shown in figure 4.39, a lever, mounted on a hinge pin, oscillates 30 degree each side of the vertical centre line; this lever is shown, chain dotted, in the two extremes of position. Comment on the machining involved and show design modifications to facilitate the machining. 
10	

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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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Product Design and Manufacturing (MPD)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
JnanaSangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

Programme Outcome:

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.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech., Product Design and Manufacturing (MPD) (Font 09 Capital, Calibri)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	22MPD31	Product Analysis & cost optimization	03	00	02	1	50	50	100	4
2	PEC	22MPD32X	Professional elective 3	03	00	00	03	50	50	100	3
3	OEC	22MPD33X	**Professional Elective 4**	03	00	00	03	50	50	100	3
4	PROJ	22MPD34	Project Work phase -1	00	06	00	--	100	--	100	3
5	SP	22MPD35	Societal Project	00	06	00	--	100	--	100	3
6	INT	22MPDI36	Internship	(06 weeks Internship Completed during the intervening vacation of II and III semesters.)			03	50	50	100	6
TOTAL				**09**	**12**	**03**	**12**	**400**	**200**	**600**	**22**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Professional elective 3		**Professional Elective 4**	
Course Code under 22MPD31X	**Course title**	**Course Code under 22MPD32X**	**Course title**
22MPD/MDE/MEA/MMD/MST321	Sustainability Engineer	22MPD/MAU/MPE331	Non Destructive Testing
22MPD/MAU/MDE/MEA/MMD/MPE/MSE/MTE/MPY/MPM322	Rapid Prototyping	22MPD/MAU/MPE/MST/MTE/MPE332	Hydraulics & Pneumatics
22MPD/MDE/MEA/MMD/MST/MPT/323	Design of Experiments	22MPD333	Soft computing Techniques
22MPD324	Virtual Design and Manufacturing	22MPD334	Mechatronics in manufacturing systems
22MPD325	Industrial Robots and Expert Systems	22MPD335	Lean Manufacturing Systems

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to work out/proposing viable solutions for societal problems.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE

(University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase-1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech., Product Design and Manufacturing (MPD) (Font 09Capital, Calibri)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	22MPD41	Project work phase -2	--	08	03	100	100	200	18
			TOTAL	--	**08**	**03**	**100**	**100**	**200**	**18**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

SEMESTER - III

PRODUCT ANALYSIS AND COST OPTIMIZATION			
Course Code	22MPD31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 theory + 10-12 activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To understand the basic knowledge of accounting, types of accounting and importance of accounting.
- To understand various financial ratios and their applications in decision making.
- To learn about various elements and methods of costing.
- To prepare engineering students to analyze cost/revenue data.
- To carry out or make economic analyses in the decision making process.
- To justify or reject alternatives/projects on an economic basis.

Module-1	
Introduction: New products, new product strategy -market definition Idea generation introduction to the design process -forecasting sales potential -product engineering and markets- monopoly competitive. Manufacturing Planning: Selection of optimum process, standardization. Break even analysis- application and area of use - problems -multi - product analysis. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Value Analysis: Steps in selection, analysis and implementation, Selection of cutting speed for optimum cost - problems. Cost Accounting: Cost estimation -difference -types -steps involved in cost estimation 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Types of Cost: Cost Centres, Direct –indirect, material cost -direct indirect material cost Overhead cost, Elements in overheads: Preparation of cost sheet, machine hour rate, apportioning methods 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Variance Analysis – Labour variance, Material variance and Overhead variance, Activity based costing - Introduction to target costing. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Cost Calculation: Cost calculation for machined components, welding, casting and forged components illustrations - calculation of sales cost. Cost Optimization Techniques: Analytical, Graphical and incremental methods Learning curves 08Hrs	
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
6.

Suggested Learning Resources:

Books

- Design and Marketing of New Products - Glen L Urban - John R Hauser- Prentice Hall. New Jersey, 1980.
- Production and Costing - Narang CBS & Kumar V - Khanna Publishers- 2001
- Cost management in the New Manufacturing Age -Yasuhiro Monden, ProductivityPress- 1992
- Technique for Value Analysis And Engineering - Miles Lewrence.D- McGraw Hill, Newyork-1972

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case Study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse the Selection of optimum process, standardization. Break even analysis	
CO2	Understand the Steps in selection, analysis and implementation, Cost estimation.	
CO3	Understand the different types of cost.	
CO4	Understand the different types Variance Analysis.	
CO5	Analyse the various Cost Optimization Techniques.	

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	3	3	2	2	3
CO2	3	2	3	2	1	3	2
CO3	3	3	2	1	2	3	2
CO4	3	2	3	3	2	3	3
CO5	2	3	3	2	3	2	2

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

SUSTAINABILITY ENGINEERING			
Course Code	22MPD/MDE/MEA/MMD/MST321	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 have an increased awareness among students on issues in areas of sustainability
- To understand the role of engineering and technology with sustainable development.
- To know the methods, tools and incentives for sustainable products service system development
- To establish clear understanding of the role and impact t of various aspects of engineering decisions on environmental, societal and economic problems

Module-1	
Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, legal provisions for environmental protection. 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), 05Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport 05 Hrs	
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**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

- Allen, D .T. and Shonnard, D .R., Sustainability Engineering: Concepts, Design and case studies, Prentice Hall
- Bradley, A.S; Adebayo, A.O; Maria, P, Engineering applications in sustainable design and development, Cengage learning.
- Environmental Impact assessment guidelines, Notification of Govt of India, 2006.
- Mackenthun, K M; Basic concepts in Environmental management, Lewis publication, London 1998
- Ni bin Chang, Systems analysis for sustainable engg Theory and applications, Mcgraw Hill professional.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Case study
- 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 the relevance and the concept of sustainability and the global initiatives in this direction	
CO2	Explain the different types of environmental pollution problems and their sustainable solutions	
CO3	Discuss the environmental regulations and standards	
CO4	Outline the concepts related to conventional and non-conventional energy	
CO5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles	

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	3	1	2	2	3
CO2	2	3	3	2	2	3	3
CO3	3	2	2	3	2	3	2
CO4	2	3	3	2	2	3	3
CO5	3	3	2	3	2	3	3

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

Professional Elective-3			
RAPID PROTOTYPING			
Course Code	22MPD/MAU/MDE/MEA/MMD/MPE/MSE/MTE/MPY/MPM322	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:

- Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
- Applying of measurement and scaling technique for prototype manufacturing.
- Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning

Module-1	
Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Selective Laser Sintering and Fusion Deposition Modelling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modelling, Process parameter, Path generation, Applications. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Solid Ground Curing: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
RP Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation. 08Hrs	
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

- Stereo lithography and other RP & M Technologies -Paul F. Jacobs - SME, NY1996
- Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London2001.
- Rapid automated - Lament wood - Indus press NewYork (4)Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.	
CO2	Explain direct metal laser sintering, LOM and fusion deposition modelling processes.	
CO3	Demonstrate solid ground curing principle and process.	
CO4	Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components.	
CO5	Understand the RP Process Optimizations.	

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	3	2	2	3	3
CO2	3	3	2	2	3	3	2
CO3	3	2	2	3	2	3	3
CO4	3	3	2	3	3	2	3
CO5	2	3	3	2	1	3	2

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

Professional Elective-3			
DESIGN OF EXPERIMENTS			
Course Code	22MPD/MDE/MEA/MMD/MST/MPT /323	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 understand the importance of design of experiments
- To describe how to design experiments ,carry them out and analyse the data they yield
- To investigate the logic of hypothesis testing including analysis of variance and detailed analysis of experimental data.
- Create designs that have a minimal sensitivity to input variation
- Determine which design parameters have the largest impact on variation
- Optimize designs with multiple outputs.

Module-1

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE‟s algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples. Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Largerthe-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples. Parameter and tolerance design concepts, Taguchi‟s inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples. 08Hrs

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

- Design and Analysis of Experiments, Douglas C Montgomerry, Wiley, 8th Edition
- Design and Analysis of Experiments, R. Panneerselvam, PHI
- Design of Experiments with Minitab, Paul Mathews, New Age International.
- Design of Experiments with Minitab, Virgil L Anderson and Robert A Mclean, Taylor and Francis

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Critically review basic concepts and models of experimental design.	
CO2	Analyse the results of a designed experiment in order to conduct the appropriate statistical analysis of the data.	
CO3	Interpret statistical results from an experiment and report them in non-technical language	
CO4	Understand the different types of orthogonal arrays.	
CO5	Analyse the Taguchi‟s inner and outer arrays, parameter design strategy.	

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	3	2	3	2	3
CO2	3	3	2	3	3	2	3
CO3	3	2	3	3	2	3	3
CO4	3	3	2	3	1	3	2
CO5	2	3	3	2	3	2	2

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

VIRTUAL DESIGN AND MANUFACTURING

Course Code	22MPD324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To teach students how to formulate the design and manufacturing problem for simple systems and mechanical components
- To teach students how to apply the general mechanical engineering sciences in analyses specific to the design of mechanical components and systems
- To teach students in a laboratory setting how to generate concepts, conduct analyses to size components, construct and assemble a prototype of a system and test its function
- To reinforce students team skills through team projects, including problem formulation, problem solutions and written and oral reporting of results
- To reinforce student's visualization and hands-on skills through project virtual prototyping and/or physical construction exercises

Module-1

Review of Computer Graphics: Review of computer graphics, 2D graphics.2D primitives and transformations. Algorithm to digitize the graphic entities, rasterization, 3D graphics.3D primitives and transformations, projections and viewing, algorithms for hidden line removals, lighting. Shading and ray tracing. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

VR Devices: Input devices-track balls, 3D Mouse, data gloves, Virtual hand and trackers, output devices graph terminal, stereo glasses, head mounting devices, vision dome, caves. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Applications: Virtual prototyping, behavior simulation, digital mockup, walk through/flythrough. Virtual training/simulation, micro electro mechanical systems and nanotechnology 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Virtual Modeling language: History, Concepts, syntax, basic nodesgroup, transform switch, LOD etc, geometry nodes-indexed face set, indexed line set, coordinate, coordindwx, textures etc. sensor nodestime sensor touch sensor, sphere sensor, cylinder sensor and proximity sensor, scriping- VRML Script and JAVA Script. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Tutorials and samples: VRML authoring tools-3D studio MAX, cosmo World, VRML Pad (editor) VRML Viewing tools-cosmo player, auto Vue, SGI's open inventor, virtual collaborative tools 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:

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

- Computer Graphics-Principles and practice - JanesD,Foley et al., - Second edition. inC,Addision -Wesley 1997.
- The VRML- 2.0 Hand book - Jed Hartman and Josie wernecke - Addision-Wesley-1997. The Annocated VRML 2.0 hand book Addition - R Carey and G Bell -Wesley1997.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand functional and manufacturing requirements, utilize concept generation	
CO2	Weigh tradeoffs in concept and detail design from the perspectives of function,	
CO3	Compile reference (catalog, handbook and textbook) resources to formulate an	
CO4	Make decisions regarding buy or build for individual components of a design	
CO5	Formulate, in a team setting or independently, a test plan that encompasses all	

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	3	2	2	1	3	3
CO2	3	3	2	3	2	3	3
CO3	3	3	2	3	3	2	3
CO4	3	2	3	3	2	3	3
CO5	2	2	3	2	3	2	3

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

Professional Elective-3			
INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS			
Course Code	22MPD325	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:

- This course will provide exposure about the robots and expert systems which are the two main components of an advanced manufacturing system.
- This exposure will help the student in selection, design and simulation of robots and expert systems.

Module-1	
Introduction and Robot Kinematics Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Robot sensors Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Robot drives and control Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers. Robot Cell Design and Application Robot work cell design and control – Safety in Robotics. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Methods of Robot Programming Robot Programming, Artificial Intelligence and Expert Systems - Characteristics of task level languages lead through programming methods – Motion interpolation. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Artificial intelligence Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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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

- K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
- Yoram Koren," Robotics for Engineers'", Mc Graw-Hill, 1987.
- Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985
- Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
- Deb, S.R."Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
- Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
- Timothy Jordanides et al,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case Study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain about the robots and expert systems which are the two main components of an advanced manufacturing system.	
CO2	Select, design and simulate robots and expert systems.	

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	3	2	3	3	2
CO2	3	3	2	3	2	3	2

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

Professional Elective 4			
NON DESTRUCTIVE TESTING			
Course Code	22MPD/MAU/MPE331	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:

- Discuss the terminology and basic concepts of materials and structure failure mode, and failure mechanisms
- Identify and Apply appreciate NDT methods for Materials and Structural health monitoring and sensing
- Explain the typical data acquisition and signal visualization involved in commonly used NDT methods

Module-1	
Magnetic Particle Inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Eddy Current Inspection: principles, operation variables, procedure, inspection coils, and detectable discounts by the method. Microwave Inspection: Microwave holography, applications and limitations. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Ultrasonic Inspection: Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Radiography Inspection: Principles, radiation source X-rays and gamma rays, X-ray tube, radiographic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Optical Holography: Basics of Holography, recording and reconstruction. Acoustical Holography: systems and techniques applications. Indian standards for NDT. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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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

- Non Destructive Testing McGonnagle JJ – Garden and reach New York.
- Non Destructive Evolution and Quality Control volume 17 of metals hand book 9 edition Asia internal 1989.
- The Testing instruction of Engineering materials Davis H.E Troxel G.E wiskovilC.T McGraw hill.

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	Distinguish the destructive and non-destructive testing and find effectiveness	
CO2	Find the surface defect using liquid penetrant and magnetic particle test and eddy current test.	
CO3	Learn the mechanism of flaw detection using ultrasonic wave system.	
CO4	Understand the operations of microwave and radiography inspection system.	
CO5	Understand the basics of holography and interferometry and its application in defect detection.	

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	3	3
CO2	3	3	2	3	2	3	3
CO3	3	3	3	2	3	2	2
CO4	3	3	3	2	1	3	3
CO5	3	3	2	1	2	3	2

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

Professional Elective 4			
HYDRAULICS AND PNEUMATICS			
Course Code	22MPD/MAU/MPE/MST/MTE/MPE332	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 Study the fundamentals of Hydraulic Power Pumps, Actuators and Motors.
- To develop a sound knowledge of control components in Hydraulic Systems.
- To have basic skills to design Hydraulic Circuits and analyze them.
- To acquire the fundamental knowledge on pneumatic control.
- To develop skill sets to handle Pneumatic Actuators , Valves, Pneumatic circuits and logic circuits

Module-1

Introduction to Hydraulic Power and Pumps: review of fluid mechanics, Pascal's Law, structure of hydraulic control system. pumps: pumping theory, pump classification, gear pumps- external and internal type, vane pumps- simple, balanced, pressure compensated types, piston pumps- radial and axial (both swash plate and bent axis type), pump performance.

Hydraulic Actuators and Motors: Linear hydraulic actuators - single acting, double acting, tandem cylinder, telescopic rod cylinder, mechanics of hydraulic cylinder loading, cylinder cushioning, hydraulic rotary actuators, hydrostatic transmission – open and close circuit, performance of hydraulic motor.

10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Control Components in Hydraulic Systems: directional control valves (DCV), constructional features, 2/2,3/2,4/2,4/3 DCV, center configuration in 4/3 DCVopen, closed, tandem, regenerative, floating centre configuration, actuation of DCVs- manual, mechanical, solenoid, and indirect actuation, relays for the solenoid operation, check valve, pilot check valve, pressure control valves – direct and pilot operated types, pressure reducing valve, flow control valvesfixed throttle, and variable throttle, throttle check valve, pressure compensated flow control valve- relief and reducing type. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Hydraulic Circuit Design and Analysis: control of single and double acting hydraulic cylinder, regenerative circuit, counter balance valve application, cylinder sequencing circuits, cylinder synchronizing circuits, speed control of hydraulic cylinder – meter in and meter out, speed control of hydraulic motors, relay circuit design for the operation of solenoid directional control valve- single and double solenoid relay circuit 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Introduction To Pneumatic Control: choice of working medium, characteristics of compressed air, structure of pneumatic control system , supply, signal generators, signal processor, final control elements , actuators, production of compressed air – compressors - reciprocating and rotary type, preparation of compressed air – driers, filters, regulators, lubricators, distribution of compressed air – piping layout. 10 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Pneumatic Actuators , Valves: linear cylinder – types, conventional type of cylinder – working, directional control valve, shuttle valve, quick exhaust value, twin pressure valve, direct and indirect actuation of pneumatic cylinder, memory valve, time delay valve. Pneumatic circuits and logic circuits: supply air and exhaust air throttling, will dependent circuits, travel dependent controls – types – construction – practical applications, cylinder sequencing circuits, travel step diagrams, practical examples involving two or three cylinders, use of logic functions – OR, AND, NOR, NAND,YES, NOT functions in pneumatic applications, practical examples involving the use of logic functions.

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.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
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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

- S.R.Majumdar-Pnematic System, TMH, 1995
- Antony Esposito, Fluid Power Systems and Control, Prentice Hall,1998
- R.Srinivasan, Hydraulic and Pneumatics control published by Vijay Nicole Imprints Private Ltd.
- Andrew Parr, Hydraulic and Pneumatics, Butterworth-Heinemann
- Herbert R Merritt, Hydraulic control systems, John Wiely& Sons, Newyork,1967.
- Dudbey A Peace, Basic fluid power, Prentice hall Inc,1967.
- Peter Rohner, Fluid power logic circuit design, Macmillan press Ltd, London,1979.
- Peter Rohner, Fluid Power logic circuit design, Mcmelan prem,1994.
- Servo Pneumatics D Schilz A Zimmermann

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case Study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Recall the basic concept of fluid mechanics; identify different components of hydraulic system.	
CO2	Analyze the requirement of control components and their selection.	

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	3	2	2	3	2	3
CO2	3	3	2	3	3	2	3

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

Professional Elective-			
SOFT COMPUTING TECHNIQUES			
Course Code	22MPD333	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:

- Provides the student with basic knowledge of the industrial automation systems design, installation, modification, maintenance, and repair.
- To study about various sensors and its industrial applications.

Module-1	
Introduction to Soft computing: Neural networks, Fuzzy logic, Genetic algorithms, Hybrid systems and its applications., 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Fundamental concept of ANN, Evolution, basic Model of ANN, Terminologies used in ANN, MP Model, Hebb model 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Perceptron Network: Theory, Perceptron Learning Rule, Aichitecture, Flowchart for Training Process, Perceptron Training Algorithm for Single Output Classes, Perceprron Training Algoriilim for Multiple Output Classes, Perceptron Necwork Testing Algorithm, **Adaptive Linear Neuron (Adaline)** , Theory , Deha Rule for Single Output , Architecture,4 Flowchart for Training Process , Training Algorithm. 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Multiple adaptive linear neurons, Back propagation Network (Theory, Architecture, Algorithm for training, learning factors). 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Introduction to classical sets – operation operations on classical sets- Union – intersection- complement-difference and fuzzy sets - Fuzzy set operations- union, intersection, complement, more operation on fuzzy sets : Classical relations and fuzzy relations, 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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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

- Shivanandam, Deepa S. N Principles of Soft computing Wiley India 2011
- S.R. Jang, C.T. Sun, E. Mizutani Neuro-fuzzy and soft computing Phi (EEE edition), 2012

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Related Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Implement machine learning through neural networks	
CO2	Design Genetic Algorithm to solve the optimization problem.	
CO3	Develop a Fuzzy expert system.	
CO4	Model Neuro Fuzzy system for clustering and classification	

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.	
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Mapping of COS and Pos (indicative only)

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

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

Professional Elective 4			
MECHATRONICS IN MANUFACTURING SYSTEMS			
Course Code	22MPD334	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 introduce the integrated field of mechatronics.
- To impart knowledge about different components of a mechatronic system.
- To familiarize typical practical common application of mechatronics.

Module-1	
Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics -Measurement Systems – Control Systems 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Sensors and transducers: Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges – Eddy current sensor - Hall effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Actuators: Mechanical - Electrical - Fluid Power - Piezoelectric –Magneto strictive- Shape memory alloy - applications - selection of actuators. Programmable Logical Controllers: Introduction - Basic structure – Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Designing - Possible design solutions-Traditional and Mechatronics design concepts 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Case studies of Mechatronics systems - Pick and place Robot – Conveyor based material handling system - PC based CNC drilling machine – Engine Management system - Automatic car park barrier - Data acquisition Case studies 08Hrs	
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

- Devadas Shetty and Richard A. Kolk, "Mechatronics systems design", PWS Publishing company, 2007.
- Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
- Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applicatlions" Tata McGraw-Hill Publishing company Limited, 2003.
- Michael B. Histand and Davis G. Alciatore," Introduction to Mechatronics and Measurement systems". McGraw Hill International edition, 1999.
- Bradley D.A, Dawson. D, Buru N.C and Loader A.J, "Mechatronics" Nelson Thornes ltd, Eswar press, Indian print, 2004.
- Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics", Prentice Hall of India Pvt Ltd, 2000.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the function of basic mechatronics systems and components	
CO2	Development of Programmable Logic controller programming and implementation of real-life system	
CO3	Devise simple mechatronics systems for practical applications	

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	3	2	3	3	2
CO2	2	3	2	3	3	2	3
CO3	3	3	2	3	2	3	3

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

Professional Elective 4			
LEAN MANUFACTURING SYSTEMS			
Course Code	22MPD335	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:

- The student will be equipped with the basic knowledge of lean manufacturing, tools, techniques and implementation outcomes.

Module-1	
Just in time production system. JIT Logic -Pull system Japanese approach to production elimination of waste - JIT implementation requirements JIT application for job shops, Case studies 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Kanban system:-Kanban rules supplier Kanban and sequence schedule used by supplier. Monthly information & daily information. Later replenish system by Kanban sequenced withdrawal P system by sequence schedule table - problems & counter measures in applying Kanban system to subcontractors -Supplier Kanban circulation in the paternal manufacturer - structure of supplier Kanban sorting office. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
The rise of lean production: - Birth place, concrete example, company as community, Final assembly plant, product development and engineering. Changing customer demand, dealing with the customer, future of lean production. Shortening of production lead times: reduction of setup times, practical procedures for reducing setup time. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Standardization of operations: Machine layout, multi function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements. Elements of lean production viz G M Framingharn: Toyota Takaoka Mass Production V /s lean production, diffusing lean production. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Managing lean enterprise:-Finance, Career ladders, geographic spread and advantages of global enterprise. Prospects for catching up. Simplicity in the natural state: institutional factors -life time employment -educational commodities - quality & productivity in full circle 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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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.

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.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Productions and Operations Management – Chasel Aquilino – Dream tech latest edition.
- Toyoto Production System -An integrated approach to Just in Time - Yasuhiro Monden - Engineering aild Management Press -Institute of Industrial Engineers Norcross Georgia -1983.
- The Machine that changed the World. The Story of Lean Production - James P Womack - Daniel TJones and Daniel Roos -Harper Perennial - edition published 1991.
- Lean Thinking - James Womack – ISBN 0743249275 –2003.
- Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Schourberger - ASQC Press1991.
- Quality Function Development - James Bossert - ASQC Press1991

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Case Study

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To understand issues & challenges in implementing & developing lean manufacturing techniques from TPS & its contribution for improving organizational performance.	
CO2	Apply lean techniques to bring competitive business culture for improving organization performance.	
CO3	Analyze how lean techniques can be applied to manufacturing & service industry	
CO4	Developing lean management strategy for Supply chain management.	
CO5	. Analyzing how lean technique can create value generation for organization	

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	3	2	1	2	3	2
CO2	3	3	2	3	3	2	3
CO3	3	3	2	2	3	3	2
CO4	3	3	2	3	2	2	3
CO5	3	3	2	3	3	2	3

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

PROJECT WORK PHASE – 1			
Course Code	**22MPD34**	CIE Marks	100
Number of contact Hours/Week	**0-6-0**	SEE Marks	**--**
Credits	**03**	Exam Hours	**--**

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.
Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

Course Outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

- CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of **50:25:25**.
- There will be **no SEE**.

INTERNSHIP			
Course Code	**22MPDI36**	CIE Marks	50
Number of contact Hours/Week	**6 Weeks**	SEE Marks	50
Credits	**06**	Exam Hours	03

Course Objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.

The objectives are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

Internship: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics.

Continuous Internal Evaluation

CIE marks for the Internship report, presentation and question and answer session shall be awarded in the ratio of 50:25:25 for the **total CIE of 50 marks** by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded in the ratio of 50:25:25 for the **total SEE of 50 marks** (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

IV SEMESTER

PROJECT WORK PHASE -2

Course Code	**22MPD41**	CIE Marks	100
Number of contact Hours/Week	**8 Hours/Week**	SEE Marks	100
Credits	**18**	Exam Hours	03

Course Objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Course Outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.