VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech. Mechatronics (MTR)
(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. Mechatronics (MTR)
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	22MTR/MCM11	Applied Mathematics	03	00	00	03	50	50	100	3
2	IPCC	22MTR12	Fluid Power Automation	03	02	00	03	50	50	100	4
3	PCC	22MTR13	Advanced Control Systems	03	00	02	03	50	50	100	4
4	PCC	22MTR14	Mechatronics System Design	02	00	02	03	50	50	100	3
5	PCC	22MTR15	Sensors And Signal Conditioning	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	22MTRL17	Fluid Power Automation Lab	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- MandatoryCredit 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): 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 specialisation as well allied fields that leads toemployable 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

Applied Mathematics Common to MTR/MCM			
Course Code	22MTR11	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:

1. To have an insight into solving roots of equations.
2. Learn to use the roots of polynomial.
3. To learn system of linear algebraic equations.
4. To Learn concepts of linear transformation.`

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model. Roots of Equations: Bracketing Methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed-point iteration.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Roots of Polynomial-Polynomials in Engineering and Science, Muller‟s method, Numerical Differentiation and Numerical Integration: Newton – Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration,NumericalDifferentiationAppliedtoEngineeringproblems,HighAccuracy differentiation formulae. MATLAB or SciLab session for Numerical differentiation and Numerical Integration**.**

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer‟s Rule, GaussElimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method,error Analysis for direct methods, Iteration Methods. MATLAB or Sci Lab session for solving system of equations usingCramer‟s Rule,Gausselimination methodand Gauss-Jordanmethod.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method forsymmetric matrices, Householder‟s method for symmetric matrices, Rutishauser method for arbitrary matrices, Powermethod,Inversepowermethod.MATLABorSciLabsessionforfindingeigenvaluesandeigenvectorsofasquarematrix.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models inScience and Engineering. Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets. Model some simple mathematical models of physical Applications and Find the roots of polynomials in Science and Engineering problems.

08 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

1. S.S.Sastry,Introductory Methods of Numerical Analysis, PHI,2005.
2. StevenC. Chapra,Raymond P.Canale, Numerical Methods for Engineers,Tata Mcgraw Hill,4thEd,2002.
3. MKJain,S.R.KIyengar,RK.Jain,NumericalmethodsforScientificand enggcomputation,NewAgeInternational,2003.
4. PervezMoin,FundamentalsofEngineeringNumerical Analysis,Cambridge,2010
5. David.C. Lay, LinearAlgebra anditsapplications,3rdedition,PearsonEducation,2002.

Web links and Video Lectures (e-Resources):

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

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	Use the numerical methods for solving algebraic and transcendental equations which comes in mechanical engineering courses	5
CO2	Demonstrate common numerical methods and how they are used to obtain approximate solutions	4
CO3	Analyze and evaluate the accuracy of common numerical methods.	3
CO4	Apply modern tools numerical methods to solve problems	5
CO5	Write efficient code and present numerical results in an informative way.	5

Program Outcome of this course

Sl. No.	Description	Pos
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

FLUID POWER AUTOMATION			
Course Code	**22MTR12**	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. The goal of the course is to familiarize the students with the concepts and techniques in Fluid Power Automation in engineering systems.
2. Make the students acquainted with the theoretical aspects of Automation
3. Enable the students to acquire practical experience in the field of Automation through design projects
4. Make the students to understand the importance of Automation in various fields of engineering.

MODULE-1

Fluid Power Generating/Utilizing Elements: Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-drive characteristics-Linear actuator- Types, mounting details, cushioning-power packs-construction, reservoir capacity, heat dissipation, accumulators-standard circuit symbols, circuit (flow) analysis.
Control and regulation elements: Direction flow and pressure control valves-method of actuation, types

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2

Comparison of Hydraulics and Pneumatics: need for Automation, Hydraulic and Pneumatic comparison-ISO symbols for fluid power elements, Hydraulic, pneumatics- Selection criteria and examples related to selection criteria.
Advanced Hydraulics: Types of proportional control devices-pressure relief, flow control, directional control, Hydraulic symbols, Spool configurations, electrical operation, Basic electrical circuit and operation, solenoid design, comparison between conventional and proportional valves. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3

Method of control : Comparison between analogue and digital control, Proportional attributes, Ramp, Gain, dead band, Dither, Pulse width modulation, Amplifier cards, Principles of operation, Design and application, Analogue and digital, Closed loop, Internal and external feedback devices, Operation and application of closed loop system, Integrated electronics option frequency Response, Principles of operation, Bode diagrams and their use in manufacturer's data, PID control, Practical exercises, Commissioning and set up procedures, open loop circuits, closed loop circuits, Interface to the control. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4

Electrical Control of Fluid power: Electrical control of Hydraulics and Pneumatics, use of relays, Timers, counters, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits, Electronic circuits for various open loop control and closed loop (Servo) control of Hydraulics and **Pneumatics. Circuit Design:** Typical industrial hydraulic circuit design methodology- Ladder diagram- cascade, method-truth table 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE 5

Application of Propositional and Servo Valves : Velocity control, Position control and Directional control and applications example: paper industry, process industry, printing sawmill, wood working, extrusion press, power metallurgical press, continuous casting, Food and packaging, Injection moulding, Solar energy and automobile. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments

1	Draw and interpret schematic diagrams consistent with industrial practice related to fluid power systems
2	Apply Pascal and Bernoulli's laws to investigate the relationships within fluid systems
3	Determine horsepower and efficiency for fluid power systems.
4	Size pipes, pumps, motors, cylinders, and accumulators.
5	Size air compressors to handle the pneumatic systems requirement.
6	Interpret sequence diagrams that utilize relay and coil logic.
7	Work in teams to accurately collect data and report results in an industrial accepted format.

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)

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

(1) Pneumatic System, S.R.Majumdar,TMH, 1995
(2) Fluid Power Systems and Control, Antony Esposito, Prentice Hall,1998
(3) Hydraulic and Pneumatics control, R.Srinivasan, Vijay Nicole Imprints Private Ltd.
(4) Hydraulic and Pneumatics, Andrew Parr, Butterworth-Heinemann
(5) Hydraulic control systems, Herbert R Merritt, John Wiely& Sons, Newyork,1967.
(6) Basic fluid power, Dudbey A Peace, Prentice hall Inc,1967.
(7) Fluid power logic circuit design, Peter Rohner,Macmillan press Ltd, London,1979.
(8) Fluid Power logic circuit design, Peter Rohner, Mcmelan prem,1994.

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	Analyse and identify the functional requirements of a fluid power.	5
CO2	Identify the various applications of fluid power.	4
CO3	Differentiate between fluid power and transport systems.	3
CO4	Apply concept of fluid power for the industrial applications of fluid power	5
CO5	Analyze and design hydraulic and pneumatic circuits	5

Program Outcome of this course

Sl. No.	Description	Pos
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

Advanced Control Systems			
Course Code	22MTR13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.

Module-1

Mathematical models of Physical systems, Performance specification, Root locus analysis and design, **frequency domain analysis and design Sampled data control systems** – Introduction to control systems , Sampling process; Sample and Hold circuit; Types of signals ; Mathematical operation on discrete time signals; Z-transform; Properties of Z-transforms; Inverse Z-transform; Solving the differential equations using Z-transform; and its Applications. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

State space analysis- concepts of states; State space formulation; State model of linear system; State diagram and signal flow graph; State-space representation using physical variables-Electrical systems and mechanical translational system; State-space model of Mechanical translational systems and Rotational system. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Stability, Controllability and Observability- Linear discrete-time systems(LDS); Transfer function of LDS systems; Stability analysis of sampled data control systems using Jury's stability test, Bilinear transformation and Root locus technique; Similarity transformation; Eigen values and Eigen vectors; Canonical form of state model; Controllability test and Observability test using Gilbert's method of testing, Kalman test and Duality property. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Nonlinear systems- Introduction to Nonlinear systems; common physical non linearity's; Describing function; Derivation of describing function of dead-zone and saturation nonlinearity; Derivation of describing function of saturation nonlinearity; Derivation of describing function of dead-zone nonlinearity; Derivation of describing function of relay with dead-zone and hysteresis. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Derivation of describing function of Backlash nonlinearity; Describing function analysis of nonlinear systems using polar plot and Nichols plot ; Phase plane and phase trajectories; Singular points; Stability analysis of nonlinear systems using phase trajectories ; Construction of phase trajectories by- analytical method, Isocline method, delta method; Jump response; Liapunov's stability criterion; Popov's stability criterion. 08 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:

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

(1) "Control Systems Engineering", J. Nagarath and M. Gopal, New Age International (P)Limited,
(2) Publishers, Fourth edition – 2005
(3) "Fundamentals of Signals & Systems", Michael Roberts, 2nd ed, Tata M cGraw-Hill,2010.

Reference Books

(1) "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition,2002.
(2) "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines,TMH, 2nd Edition 2007.
(3) "Discrete Time Control Systems", Ogata K., Addison Wesley Longman, 2nd Edition,2000.

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	Analyse various control systems.	5
CO2	Acquire knowledge of transfer function of systems using signal flow graph and block diagram reduction.	4
CO3	Analyse stability of systems.	4
Co4	Apply time domain analysis of control systems.	5
C05	Analyse frequency domain of control systems	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Mechatronics System Design			
Course Code	22MTR14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Mechatronics Design aims to provide students with knowledge, skills, and exposure to the integrated design process of mechatronics systems.

Module-1

Introduction to Mechatronic System Design: Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Modelling of Mechatronics system: Need for modelling – systems overview – representation of systems (block diagram, signal flow graphs, transfer function and state space) -Modelling technique (analytical and identification techniques) – direct method- analogue approach – bond graph approach – modelling of electrical, mechanical, thermal, fluid and hybrid systems – system identification methods overview – Least square method. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Generalized Mechatronics Design Process: Recognition of the Need, Conceptual Design and Functional Specification, First principle Modular Mathematical modelling, Sensor and Actuator Selection, Drivers for Actuators, Control System Design, Design Optimization, Prototyping, Hardware in-the-loop Simulation, Deployment/Life Cycle, Deployment of Embedded Software, Life Cycle Optimization.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Design optimization: Optimization – problem formulation - constraints – over view of linear and nonlinear programming techniques – other optimization techniques- optimal design of mechatronics system with case studies.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Fault Finding: Fault– Detection Techniques, Watch Dog Timer, Parity and Error Coding Checks, Common Hardware Faults, Microprocessor Systems, Emulation and Simulation, PLC Systems.
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:

5. Three Unit Tests each of **20 Marks**
6. 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

(1) "Mechatronic Modeling and Simulation Using Bond Graphs", Shuvra Das., CRC Press, 2009
(2) "Mechatronics – Electronic control systems in Mechanical & Electrical Engineering", W. Bolton, Pearson Education Ltd., 2003.
(3) "Mechatronics System Design", Shetty and Kolk, CENGAGE Learning, India, second edition, 2011.
(4) "Bond Graph in Modeling, Simulation and Fault Identification" Amalendu Mukherjee, Ranjit Karmakar, Arun kumar samantaray, I.K International Pvt Ltd, Jan 2006.
(5) Mechatronics - W. Bolton, Pearson Edition
(6) "Mechatronics System Design", Devadas Shetty, Richard A.Kolkm, PWS Publishing Company.

Reference Books

(1) Mechatronics -Mahalik, TMH.
(2) Mechatronics - HMT, TMH.
(3) Understanding Electro-Mechanical Engineering: An Introduction to Mechatronics -Kamm, PHI.

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	Acquire knowledge of basic system modelling.	5
CO2	Apply modelling technique for the building mechatronics system design	4
CO3	Describe fault finding techniques	5
C04	Apply design optimization for mechatronics systems developments.	5
C05	Design and implement control systems for mechatronic machines.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Sensors And Signal Conditioning			
Course Code	22MTR15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To introduce the basics of measurements.
2. To elucidate sensors and signal conditioning circuits.
3. To introduce different error analysis methods.
4. To familiarize with different sensors and transducers.
5. To explain signal conditioning circuits.

Module-1

Introduction to Measurement System: General Concepts and Terminology, Sensors Classification, General Input-Output Configuration, Static Characteristics of Measurement Systems, Dynamics Characteristics of Measurement Systems, Input Characteristics: Impendence, Primary Sensors, Problems.
Resistive Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light Dependent Resistors (LDRs), Resistive Hygrometers.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Signal conditioning For Resistive Sensors: Measurement of Resistance, Voltage Dividers, Wheatstone bridge, Balance Measurements, Instrumentation Amplifiers, and Interference.
Reactive Variation and Electromagnetic Sensors: Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Signal conditioning For Reactive Variation Sensors: Problems and Alternatives, AC Bridges, Carrier Amplifiers, variable Oscillators, Resolver– to Digital and Digital-to-Resolvers Converters.
Self-Generating Sensors: Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Photovoltaic Sensors, Electrochemical Sensors.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Signal Conditioning for Self-Generating Sensors: Chopper and Low- Drift Amplifiers, Electrometer Amplifiers, Charge Amplifiers, Noise in Amplifiers.
Digital sensors: Position Encoders, Variable Frequency Sensors. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Other transduction Methods: Sensors based on Semiconductors Junctions, Sensors based on MOSFET Transistors, Charge-Coupled Sensors, Ultrasonic based Sensors, Fiber-Optic Sensors.
Telemetry and Data Acquisition: Data-Acquisition System Structure, Telemetry Systems, Amplitude Telemetry, Frequency Telemetry.

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:

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

(1) "Mechatronics", Bolton W., Thomson Press, 2003.
(2) "Mechatronics", Bradley D.A., and Dawson, Burd and Loader, Thomson Press
(3) "Measurement system, Application and Design", Ernest O. Doeblin, Tata Mc Graw Hill Publishing
(4) Company Ltd., Fiftieth Edition, 2004

Reference Books

(1) "Sensor and Actuators", Patranabis D., Prentice Hal l of India (Pvt) Ltd.,2005.
(2) "Transducer Engineering", Renganathan S., Allied Pu blishers (P) Ltd., 2003

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	Illustrate the measuring systems and their characteristics	5
CO2	Interpret the type of sensors for particular applications	5
CO3	Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications.	4
C04	Demonstrate various signal conditioning for sensors	3
Co5	Explain the transducers and telemetry and data acquisition	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

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

Course Learning objectives:

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

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 06 Hrs

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. 08 Hrs

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. 10 Hrs

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 ofHypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using ChiSquareTests. 06 Hrs

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**
- 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

- 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	5
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	5
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	5
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	5
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leadingInternational Instruments concerning IPR	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

Fluid Power Automation Lab			
Course Code	22MTRL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Total Hours of Pedagogy	15 Hrs Theory + 10-12 lab sessions	Total Marks	100
Credits	02	Exam Hours	3 Hrs

Course objectives:

To impart knowledge on

1. Application of fluid power symbols
2. Designing a suitable hydraulic or pneumatic circuit
3. Automating an Industrial application.

Sl.NO	Experiments
	PARTA
1	Study of Hydraulic Pump and to draw characteristic curve of variable displacement pump.
2	Single rod cylinder with Pressure In-intensification (Use 4/2 DCV). Exercises on Meter- in Meter-out Circuit.
3	Application Involving 4/3 Direction Control Valve: Open Centre & Closed Center
4	Application Involving 4/3 Direction Control Valve Using motor.
	PARTB
1	Speed Control of Single Acting Cylinder. Slow speed Extension and Rapid Retraction by using pneumatic components.
2	Position Dependent Control of a Pneumatic Double Acting Cylinder with Mechanical Limit Switches.
3	Logical Control with Shuttle and Twin-Pressure Valves of pneumatic components.
4	Sequential Control of Two Double Acting Cylinders without Overlapping Signals.

Course outcomes:

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

- Ability to design and implement pneumatic components system for simple applications.
- Capability to control various types of Control Valve, Pneumatic Double Acting Cylinder
- Demonstrate various valves of pneumatic components with logic control
- Design and develop fluid power circuits to various applications.
- Interpret the specifications of the fluid power system components for various applications.

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:

Text Book

(1) Anthony Esposito, “Fluid Power with Applications”, Prentice Hall international, 7th edition, 2014.

Reference Books

(1) Jagadeesha T., “Fluid Power Control”, NPTEL Web course.
(2) FESTO, “Fundamentals of Pneumatics”, Vol I, II, III.
(3) Majumdar .S.R., “Oil Hydraulics”, Tata McGraw Hill, 2002.
(4) Werner Deppert , “Kurt Stoll, Pneumatic Application”, Vogel verlag ,1986

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech. Mechatronics (MTR)
(Effective from the Academic year 2022-23)

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

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. Mechatronics (MTR)
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	22MTR21	Automotive Electronics	02	00	02	03	50	50	100	3
2	IPCC	22MTR22	Micro and Smart Systems	03	02	00	03	50	50	100	4
3	PEC	22MTR23x	Professional elective 1	02	00	02	03	50	50	100	3
4	PEC	22MTR24x	Professional elective 2	02	00	02	03	50	50	100	3
5	MPS	22MTR25	Mini Project with Seminar	00	04	02	--	100	--	100	3
6	PCCL	22MTRL26	Advanced Control System Lab	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 22MTR24X	**Course title**	**Course Code under 22MTR25X**	**Course title**
22MTR231	Advanced Computer Concepts for Automation	22MTR241	AI&ML in industrial automation
22MTR232	Vibration Analysis	22MTR242	Industry 4.0 and IIOT
22MTR/MST233	Smart Materials and Structures	22MTR243	Python Programming for Automation
22MTR234/MPD233	Metrology and Computer Aided Inspection	22MTR244	Robotics Mechanics and Control
22MTR235	Drives and Control Systems for Mechatronics	22MTR245	Simulation Modelling And Analysis

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 consideredfor vertical progression as well asfor 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

Automotive Electronics			
Course Code	22MTR21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs Theory+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Ability to understand the fundamentals of vehicle systems and regulations.
2. Ability to identify various components of a vehicle and explain its functions.
3. Ability to gain fundamental knowledge to develop electronic controls for automotive subsystems.

Module-1

Automotive fundamentals overview – four stroke cycle, engine control, ignition system, spark plug, spark pulse generation, ignition timing, drive train, transmission, brakes, steering system, starting system.
Actuators – fuel metering actuators, fuel injector, ignition actuator
Exhaust After – Treatment System –AIR, catalytic converter, exhaust gas recirculation n (EGR), Evaporative emission systems 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Air/ fuel system – fuel handling, air intake system, air/ fuel management
Sensors: Oxygen (02/EGO) sensors, throttle position sensor (TPS), engine crankshaft angular position (CKP)sensor, magnetic reluctance position sensor, engine speed sensor, ignition timing sensor, hall effect position sensor, shield field sensor, optical crankshaft position sensor, manifold absolute pressure(MAP) sensor-strain gauge and capacitor capsule, Engine coolant temperature(ECT) sensor, intake air temperature (AIT) sensor, knock sensor, airflow rate sensor, throttle angle sensor. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Electronic Engine Control – engine parameters, variables, engine performance terms, electronic fuel control system, electronic ignition control, idle speed control, EGR control.
Vehicle motion control – cruise control, chassis, power brakes, antilock brake system (ABS), electronic steering control, power steering, traction control, electronically controlled suspension. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Communication-serial data, communication systems, protection, body and chassis electrical systems, remote keyless entry, GPS
Automotive Instrumentation– sampling, measurement & signal conversion of various parameters. Radar warning system, low tire pressure warning system, radio navigation, advance driver information system 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Integrated body- climate control systems, electronic HVAC system, Safety systems- SIR, interior safety, lighting, entertainment systems.
Automotive diagnostics – Timing light, engine analyzer, on-board diagnostic off- board diagnostics, expert systems. 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:

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

(1) "Automobile Electrical and Electronic Systems" Tom Denton, Routledge,5 edition,2017.

Reference Books

(1) understanding automotive electronics, Willian b. Ribbens, SAMS/Elsevier publishing 6th edition,2002

(2) Automotive electrics automotive electronics systems and components, Robert Bosch Gmbh, john wiley & sons ltd., 5th sedition, 2007

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	Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today's automotive industry.	5
CO2	Differentiate electronic and mechanical components used in automobile systems	4
CO3	Apply concept of integration of system components	5
CO4	Analyse and measure signal conversion parameters	4
CO5	Obtain an overview of automotive diagnostics	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Micro and Smart Systems			
Course Code	**22MTR22**	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:

The course aims to develop a detailed knowledge and critical understanding of Smart Systems technologies and the physics of MEMS devices.

MODULE-1

Glimpses of Microsystems: scaling effects, Smart materials and systems: an overview Micro sensor: Micro actuators Microsystems examples, structural health monitoring and vibration control

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2

Microfabrication processes:Structure of silicon and other materials Silicon wafer processing; Thin-film deposition Lithography, wet etching and dry etching Bulk micromachining and Surface micromachining Wafer-bonding; LIGA and other moulding techniques Soft lithography and polymer processing Thick-film processing; Low temperature co-fired ceramic processing Smart material processing.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3

Mechanics of Solids Stresses and deformation: bars and beams Micro device suspensions: lumped modelling Residual stress and stress gradients Poisson effect; Anticlastic curvature; examples of micromechanical structures Vibrations of bars and beams Gyroscopic effect Frequency response; damping; quality factor Basic 10Hrs. micro-flows for damping calculation

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4

Types of numerical methods for solving partial differential equations, Weak form; shape functions, Iso parametric formulation and numerical integration, Implementation of the finite element method, FEM for piezoelectric

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE 5

Electronics and packaging: Semiconductor devices: basics, Signal conditioning for microsystems devices, Integration of Microsystems and microelectronics, Packaging of Microsystems: why and how, Flip-chip, ball grid, etc.; reliability, Case studies

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	Creating the Piezoresistors

2	Documenting, Cleaning & Oxidation
3	Aluminum Markers
4	Backside Alignment & Si Bulk Etch
5	Aluminum Pads, Debond & Anneal
6	Photolithography & Etching (Vias)
7	Release & Test

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 experimentsshall 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

(1) Microsystem Design, S.D. Senturia, Kluwer Academic Publishers, 2001
(2) MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, McGraw Hill, 2002.
(3) Smart Material Systems and MEMS: Design and Development Methodologies, V.K.Varadan, K.J. Vinoy, and S. Gopalakrishnan, Wiley, 2006.

Reference Books

(1) Micromachined Transducers Sourcebook, G.T.A. Kovacs, WCB McGraw-Hill, 1998.
(2) Microsensors: principles and applications, J.W. Gardner, John Wiley & Sons, 1994.
(3) Principles of Microfabrication, M. Madou, CRC Press, 1998.

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	Describe micro systems, micro sensors and type of micro fabrication processes	5
CO2	Distinguish electronic and mechanical components used in automobile systems	5
CO3	Apply concept of mechanics of solids	4
CO4	Analyse partial differentiation for micro systems	4
CO5	Describe electronic packaging of micro electronics	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-I			
Advanced Computer Concepts for Automation			
Course Code	22MTR231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Discuss Database management systems, databases and its applications
2. Familiarize the students with a good formal foundation on the relational model.
3. Outline the various systematic database design approaches

Module-1

Introduction to Big Data: Big Data and its Importance – Four V‟s of Big Data – Drivers for Big Data –Introduction to Big Data Analytics – Big Data Analytics applications. Hadoop‟s Parallel World – Data discovery – Open source technology for Big Data Analytics – cloud and Big Data –Predictive Analytics – Mobile Business Intelligence and Big Data – Crowd Sourcing Analytics – Inter- and Trans-Firewall, Analytics - Information Management. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Processing Big Data: Integrating disparate data stores - Mapping data to the programming framework Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Hadoop Mapreduce: Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms -Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed. 05Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Database Management System: Comparison of File System, Database Management System, Characteristic Features of Database Management Systems, Relational Databases. Data Base Models: DBMS Languages and Interfaces. Data Base Security and Authorization. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Big Data Tools and Techniques: Installing and Running Pig – Comparison with Databases – Pig Latin – User-Define Functions – Data Processing Operators – Installing and Running Hive – Hive QL – Tables – Querying Data – UserDefined Functions – Oracle Big Data. 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

- Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley, 5th edition, 2009
- Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today‟s Business", I Edition, Wiely 2013
- Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, IBM Corporation, 2012
- Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.
- Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O‟reilly, 2012.
- Introduction to DBMS – Date C.J, Addison Wesley, 3rd edition, 1981
- Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
- Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
- Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R

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 of big data and its importance and its applications in different sectors	3
CO2	Data identification and its extraction from various sources and transforming them for processing.	4
CO3	apply Hadoop Map-Reduce techniques for data processing	3
CO4	Describe about database, highlighting its characteristics and discuss key components of the database and providing security and authorization to the databases.	4
CO5	Apply various tools and techniques of Big Data to solve the problems.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Vibration Analysis			
Course Code	22MTR232	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 introduces the student to the fundamental theory of mechanical vibrations.

Module-1	
Introduction to basic vibration terminology and the concepts of stiffness and damping (least squares method). Differential equation of motion derived directly from Newton's laws. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Free response of damped and undamped systems having single degree of freedom. Harmonic response of systems having one degree of freedom including resonance. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Single DOF systems response to non-harmonic forcing functions. Design systems to eliminate or reduce the effects of unwanted vibration. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Use Matrix methods for analysis for equations of motion and analysis. Vibration measurement and testing, hardware and measurement of response. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Vibration of systems that cannot be described adequately with lumped-parameter. 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**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

1. William J. Palm, Mechanical Vibration, 1st Ed., J. Wiley, 2007.
2. William T. Thomson, Theory of Vibration with Applications, 4th Ed., Nelson Thornes Ltd., 2003.

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
CO 1	concepts of stiffness and damping	5
CO 2	Use Matrix methods for analysis for equations of motion and analysis	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-I			
Smart Materials and Structures			
Course Code	22MTR/MST233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Develop an essential understanding of structure-property relationship of smart materials, as well as their applications in practical applications.
2. Develop student's capability to design functional structures using smart materials; and provide students an opportunity to learn the new knowledge through project approaches.

Module-1

Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inch worm Linear Motor. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications of SMA and Problems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Vibration Absorbers: series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications.
Control of Structures: Modelling, Control Strategies and Limitations, Active Structures in Practice. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

MEMS–Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

ER and MR Fluids: Mechanisms and properties, Fluid Composition and behaviour, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others. 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

(1) Smart Material sand Structures- M.V. Gandhiand B. So Thompson, Chapmanand Hall, London; NewYork,1992.
(2) Smart Structures and Materials- B. Culshaw, Artech House, Boston,1996.
(3) Smart Structures: Analysis and Design-A.V.Srinivasan, Cambridge University Press, Cambridge, NewYork,2001.

Reference Books

(1) Piezoelectric Sensories : Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002
(2) Hand book of Giant Magneto strictive Materials-G.Engdahl, Academic Press, San Diego,Calif.;London,2000

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 behaviour and applicability of various smart material	5
CO2	Design simple models for smart structures &materials.	4
CO3	Perform simulations of smart structures & materials application Conduct experiments to verify the predictions	5
CO4	Ability to analyse vibration absorbers and control of structures	5
CO5	Exposure to MEMS	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-I			
Metrology and Computer Aided Inspection			
Course Code	22MTR234/MPD233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	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

Metrology and Techniques: Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology Instruments, Methods and new approaches. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Special Measuring Instruments and Techniques: Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Co-ordinate Measuring Machine: Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers . 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Sensors in Inspection: Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors.

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

1. Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e
2. Engineering Metrology G. Thomas and G. Butter Worth PUB
3. Sensors and Control systems in Manufacturing SabneSoloman McGraw Hill Book (4) Measurement systems: Applications & Design Doebelin International Student Edition

Reference Books

1. Optoelectronics for Technology and Engineering Robert G. Seippel Prentice Hall India
2. Interface Technology for Computer Controlled Manufacturing processes Ulrich-Rembold, Armbruster and Ulzmann Marcel Dekker Publications, NY 7
3. Optoelectronics J. Watson Van Nostrand Rein Hold (UK) Company
4. ASME, Hand book of Industrial Metrology,1998

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	Acquire the basic knowledge and practice regarding Quality Assurance through different Computer Aided Inspection and Newest Metrology Precision Instruments.	5
CO2	Basic information and real time applications of LASER technology in the field	5
CO3	Get knowledge of modern measuring technics their application for Digitizing the Production Time.	5
CO4	Get knowledge applications and principal of CMM mechanics	5
CO5	Apply various sensors for process control and product quality monitoring	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-1			
Drives and Control Systems for Mechatronics			
Course Code	22MTR235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. The course is designed to give a solid grounding of fundamental concepts of industrial automation systems and their control.
2. The course specifically focuses on architecture, components, and techniques for automation in industries.

Module-1

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Motion Laws For Rotary And Linear Systems: converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches of Robots, Control loops using Current amplifier 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing‟s, types of variables, definition of firmware, software. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Logic, Instructions & Application of PLC: What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems. 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.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann
3. Andrew Parr, Industrial drives, Butterworth – Heineamann
4. G.K. Dubey. Fundamentals of electrical drives
5. Programmable Logic Controllers by W.Bolton

Reference Books

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzerald , C. Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
4. S.K. Pillai. A First course on electric drives –Wiley Eastern 1990
5. Programmable Logic Controllers by Hugh Jack

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 basics of Electric drives	5
CO2	Explain industrial processes and selection ofd rives	4
CO3	Differentiate various control systems	5
CO4	Develop motor control circuits	5
CO5	Illustrate computer based industrial control	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

AI&ML in Industrial Automation

Course Code	22MTR241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This can contribute in industrial automation, information technology and other sectors like healthcare, agriculture, wearable, space, and meteorology through analysis of raw data, extract intelligence from that and design, develop, support and testing of AI and ML based systems along with embedded applications.

Module-1

Artificial Intelligence: What is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, **Intelligent Agents**: Agents and Environments, the Concept of Rationality, the Nature of Environments, the Structure of Agents.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Problem-solving: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search. Informed (Heuristic) Search Strategies, Greedy best-first search, A* search, Heuristic Functions, The effect of heuristic accuracy on performance. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Beyond Classical Search: : Local Search Algorithms and Optimization Problems, Hill-climbing search, Simulated annealing, Local beam search, Genetic algorithms, Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Semantic networks, Description logics, Reasoning with Default Information, Truth maintenance systems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Uncertain knowledge and reasoning: Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, and Inference by Markov chain simulation.

05 Hrs

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**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

1. Artificial Intelligence: A Modern Approach by StuartRussell and Peter Nowig, PEARSON 3rd Ed.
2. A Guide to Expert Systems - Donald A Waterman, Addison Wesley,2nd edition,1986.

References:

1. Introduction to Artificial Intelligence and Expert Systems – DAN.W.Patterson, PHI, 2nd edition, 2009.
2. Artificial Intelligence- George.F.Luger, Pearson Education, Asia, 3rd Edition,2009.
3. Artificial Intelligence: An Engineering Approach- Robert J. Schalkeff, PHI, Second edition, 1990.

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	Describe and explain the applications of AI	5
CO2	select search strategies based on application requirement.	5
CO3	Explain knowledge representation methods, discuss architecture of expert systems.	5
CO4	Application of on-line search agent for purchase application.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

Professional Elective-2			
Industry 4.0 and IIOT			
Course Code	22MTR242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. To identify areas on which the content of education should focused on in the future in terms to Industry 4.0.
2. Illustrate diverse methods of deploying smart objects and connect them to network.
3. Compare different Application protocols for IoT.

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 05 Hrs

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. 05 Hrs

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 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

What is IoT: Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. 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.

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

Suggested Learning Resources:

Books

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan,"The Concept Industry 4.0".
   Klaus Schwab,"The Fourth Industrial Revolution".
3. Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1 stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978- 9386873743)
5. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017

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	Describe Industry 4.0 and scope for Indian Industry	5
CO2	Demonstrate conceptual framework and road map of Industry 4.0	5
CO3	Describe Robotic technology and Augmented reality for Industry 4.0	5
CO4	Interpret the impact and challenges posed by IoT networks leading to new architectural models.	4
CO5	Compare and contrast the deployment of smart objects and the technologies to connect them to network	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and Pos

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

Professional Elective-2			
Python Programming for Automation			
Course Code	22MTR243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To provide exposure to basic problem-solving techniques with computers
2. To develop the logical thinking abilities and to propose novel solutions for real world problems through programming language constructs.

Module-1

Introduction to Python Programming:
Demo of Interactive and script mode, Tokens in Python – Variables, Keywords, Comments, Literals, Data types, Indentation, Operators and its precedence, Expressions, Input and Print functions. Sequential approach 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Control Structures:
Selective statements – if, if-else, nested if, if –elif ladder statements Iterative statements - while, for, Nested loops, else in loops, break, continue and pass statements. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Collections:
List: Create, Access, Slicing, Negative Indices, List Methods, and comprehensions Tuples: Create, Indexing and Slicing, Operations on tuples. Dictionary: Create, add, and replace values, operations on dictionaries. Sets: Create and operations on set.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Strings and Regular Expressions:
Strings: Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions. Regular expression: Matching the patterns, Search and replace. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Functions:
Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments, Scope of variables: Local and global scope, Recursion and Lambda functions.
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

1. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019.
2. Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.
3. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus,2nd Edition, Wiley India Edition, 2017.

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	Interpret the basic representation of the data structures and sequential programming	5
CO2	Knowledge of, and ability to use control framework terminologies	5
CO3	Ability to work out using the core data structures as lists, dictionaries, tuples, and sets.	5
CO4	Choose appropriate programming paradigms, interrupt and handle data using files to propose solution through reusable modules.	4
CO5	Propose possible error-handling constructs for unanticipated states/inputs	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Robotics Mechanics and Control			
Course Code	22MTR244	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:
Learn algorithmic approaches, mathematical models, and computational and motion control methods applicable to robotic manipulator systems; Recognize and analyze the basic mechanical and electrical systems concerning robots

Module-1	
Introduction: Effector: locomotion, and manipulation. Serial and parallel manipulators. Descriptions, Transformations and homogeneous transformation matrix. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Manipulator (serial manipulator) kinematics: Kinematic parameters, different notations, Denavit-Hartenberg (DH) representation, arm matrix. Forward and inverse kinematics. Analytical and numerical solutions. Examples 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Differential kinematics: Differential (velocity) kinematics, velocity propagation, forward differential kinematics and inverse differential kinematics. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Jacobian matrix and Manipulator statics: Mapping between configuration-space to operational-space. Jacobian matrix and Pseudo inverse concepts.Introduction to workspace singularities.Manipulator statics: Conservation of energy or power, the mapping between operation-space to configuration-space inputs examples 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Manipulator dynamics: Motion dynamics: Forward and inverse dynamics. Lagrangian (Lagrange-Euler) and Newton-Euler formulations. 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**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

1. MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS, Prof. Santhakumar Mohan, Mechanical Engineering, IIT Palakkad.
2. Introduction to Robotics: Mechanics and Control, John J. Craig, Pearson

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
CO 1	Student will have the competence to design and implement robotic systems.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**2**

Professional Elective-2			
Simulation Modelling And Analysis			
Course Code	22MTR245	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: Students will be able to

1. gain Knowledge of basics concepts and methodologies of modeling and simulation
2. understand the concepts of discrete event simulation, random number generation, test for random numbers & random varieties used in simulation study.
3. develop simulation model by simulation package for queuing system, production system and maintenance system

Module-1

System and system environment: Component of a system – Continuous and discrete systems – Types of model; Steps in Simulation study; simulation of an event occurrence using random number table – Single server queue-two server queue- inventory systems. Discrete Event Simulation: Concepts in discreet event simulation, manual simulation using event scheduling, single channel queue, two server queue, and simulation of inventory problem 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Random number generations: Properties of random numbers – Generation of Pseudo – Random numbers – techniques of generating pseudo random numbers; Test for random number; the Chisquare test-the kolmogrov smimov test – Runs test – Gap test – poker test. FCV, symbolic representation. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Random – Variate Generation: Inverse transform technique for Exponential, Uniform. Triangular, weibull, empirical, uniform and discrete distribution. Acceptance rejection method for Poisson and gamma distribution; Direct Transformation for normal distribution. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Analysis of simulated Data: Data collection, identifying the distribution, parameter estimations, and goodness of fit tests, verification and validation of simulation models. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Comparison and selection of GPSS, SIMSCRIPT, SLAM: Arena simulation languages: development of simulation models using arena simulation package for queuing system, Productions systems, maintenance system. 05 Hrs

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**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

1. Discrete, Event system Simulation, Banks J., Carson J.S. and Nelson B.L., 3rd Edition, Pearson education, Inc 2004 (ISBN 81-7808-505-4).
2. System Simulation, Geoffrey Gorden, Prentice Hall of India, 2003.
3. System Simulations and Modeling,. Narsingh deo., Prentice Hall of India 2003.
4. Computer simulations and Modeling, Francis Neelamkovil, , john Wiley & Sons, 1987
5. Simulation Modeling with Pascal, Rath M.Davis & Robert M O Keefe, Prentice Hall Inc.1989.

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	gain Knowledge of basics concepts and methodologies of modeling and simulation	5
CO2	understand the concepts of discrete event simulation, random number generation, test for random numbers & random varieties used in simulation study.	4
CO3	develop simulation model by simulation package for queuing system, production system and maintenance system	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

MINI PROJECT WITH SEMINAR			
Course Code	**22MTR25**	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.

ADVANCED CONTROL SYSTEM LABORATORY			
Course Code	22MTRL26	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Total Hours of Pedagogy	15 Hrs Theory + 10-12 lab sessions	Total Marks	100
Credits	02	Exam Hours	3 Hrs

Course objectives:

To impart knowledge on

1. Application of fluid power symbols
2. Designing a suitable hydraulic or pneumatic circuit
3. Automating an Industrial application.

Sl.NO	Experiments
	PARTA
1	Mathematical models of physical systems in the design and analysis of control systems
2	To Study the effect of P, PI, PID controllers using MATLAB.
3	To analyses the stability of linear systems using Bode, Root locus, Nyquist plots
4	To calculate an impulse response of a system described by difference equation y[n]+0.7y[n-1]–0.45y[n-2]-0.6y[n-3]=0.8x[n]-0.44x[n-1]+0.36x[n2]+0.02 x[n-3]
5	Question based on response of LTI systems to different inputs. ALTI system is defined by the difference equation y[n]=x[n]+x[n+1]+x[n+2]. (a)determine the impulse response of the system and sketch it. (b)determine the output y[n]of the system when the input is x[n]=u[n]. c)Determine the output of the system when the input is a complex exponential (E.g.[n]=2*exp(j0.26n)).
6	Comparison of DFT and DCT (in terms of energy compactness) Generate the sequence x[n]=(n-64) for=0,127. (a) Let X[k]=DFT{x[n]}. For various values of 1, set to zero "high frequency coefficients "X[64-1]= ....X[64]= ..... X[64+L]=0andtaketheinverseDFT.Plot the results. (b) Let XDCT[k]=DCT(X[n]).For the same values of L, set to zero "high frequency coefficient "XDCT[127-L]= ....XDCT[127].Take the inverse DCT for each case and compare the reconstruction with the previous case. Use Laasonen Model and Crank Nicolson Model draw the characteristic curves for various boundary conditions.

Course outcomes:

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

- Ability to design and implement pneumatic components system for simple applications.
- Capability to control various types of Control Valve, Pneumatic Double Acting Cylinder
- Demonstrate various valves of pneumatic components with logic control
- Design and develop fluid power circuits to various applications.
- Interpret the specifications of the fluid power system components for various applications.

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:

Text Book

(1) Anthony Esposito, “Fluid Power with Applications”, Prentice Hall international, 7th edition, 2014.

Reference Books

(1) Jagadeesha T., “Fluid Power Control”, NPTEL Web course.
(2) FESTO, “Fundamentals of Pneumatics”, Vol I, II, III.
(3) Majumdar .S.R., “Oil Hydraulics”, Tata McGraw Hill, 2002.
(4) Werner Deppert , “Kurt Stoll, Pneumatic Application”, Vogel verlag ,1986

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech. Mechatronics (MTR)
(Effective from the Academic year 2022-23)

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

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech. Mechatronics (MTR)
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/ Internship	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	22MTR31	Artificial Intelligence And Machine Learning	03	00	02	03	50	50	100	4
2	PEC	22MTR32X	Professional elective 3	03	00	00	03	50	50	100	3
3	OEC	22MTR33X	**Professional Elective 4**	03	00	00	03	50	50	100	3
4	PROJ	22MTR34	Project Work phase -1	00	06	00	--	100	--	100	3
5	SP	22MTR35	Societal Project	00	06	00	--	100	--	100	3
6	INT	22MTRI36	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 22MTR31X	**Course title**	**Course Code under 22MTR32X**	**Course title**
22MTR321	Image Processing and Machine Vision	22MTR/MMD/MDE/MEA/MPM331	Design Automation with IOT
22MTR322	Embedded Systems &Microcontrollers	22MTR332	Finite Element Method
22MTR323	Advanced Material technology	22MTR333	Virtual Instrumentation
22MTR324	Robotics Engineering	22MTR334	Reliability and Failure Analysis
22MTR325	Cyber Physical Systems	22MTR/MEM335	Product Design and Development

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 toworkout/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 – 2022
M.Tech. Mechatronics (MTR)
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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	22MTR41	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

Artificial Intelligence And Machine Learning			
Course Code	22MTR31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 Hrs+ 10-12 Activity sessions	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

Module-1

What is artificial intelligence? Problems, problem spaces and search, Heuristic search techniques

06 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Knowledge representation issues, Predicate logic, Representation knowledge using rules. Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Candidate Elimination Algorithm, Inductive bias of Candidate Elimination Algorithm. 06 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Decision Tree Learning:

Introduction, Decision tree representation, Appropriate problems, ID3 algorithm. Artificial Neural Network: Introduction, NN representation, Appropriate problems, Perceptrons, Backpropagation algorithm.

10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Bayesian Learning:

Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting, MDL principle, Bates optimal classifier, Gibbs algorithm, Navie Bayes classifier, BBN, EM Algorithm

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Instance-Base Learning: Introduction, k-Nearest Neighbour Learning, Locally weighted regression, Radial basis function, Case-Based reasoning. Reinforcement Learning: Introduction, The learning task, Q-Learning.

10Hrs

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 **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

Textbooks:

1. Tom M Mitchell,"Machine Lerning",1 st Edition, McGraw Hill Education, 2017.
2. Elaine Rich, Kevin K and S B Nair, "Artificial Inteligence", 3 rd Edition, McGraw Hill Education, 2017.

Reference Books:

1. Saroj Kaushik, Artificial Intelligence, Cengage learning
2. Stuart Rusell, Peter Norving , Artificial Intelligence: A Modern Approach, Pearson Education 2nd Edition
3. AurÈlienGÈron,"Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, Shroff/O'Reilly Media, 2017.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
5. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press
6. Srinivasa K G and Shreedhar, " Artificial Intelligence and Machine Learning", Cengage

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	Appaise the theory of Artificial intelligence and Machine Learning.	5
CO2	Illustrate the working of AI and ML Algorithms.	5
CO3	Demonstrate the applications of AI and ML.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-III			
Image Processing and Machine vision			
Course Code	22MTR321	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 objectives are to develop your understanding of the basic principles and techniques of image processing and image understanding, and to develop your skills in the design and implementation of computer vision software.

Module-1

Introduction and Digital Image Fundamentals Motivation & Perspective, Applications, Components of Image Processing System, Fundamentals Steps in Image 20% Processing, Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, Distance Measures between pixels 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Image Enhancement in the Spatial and Frequency Domain Image enhancement by point processing, Image enhancement by neighborhood processing, Basic Gray Level 20% Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Zooming, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods. Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Image Restoration and Image Compression Model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations. Data Redundancies, Image Compression models, Elements of Information Theory, Lossless and Lossy compression, Huffman Coding, Shanon-Fano Coding, Arithmetic Coding, Golomb Coding, LZW Coding, Run Length Coding, Loss less predictive Coding, Bit Plane Coding, Image compression standards.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Image Segmentation and Morphological Image Processing Discontinuity based segmentation, similarity based segmentation, Edge linking and boundary detection, 20% Threshold, Region based Segmentation Introduction to Morphology, Dilation, Erosion, Some basic Morphological Algorithms

08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Object Representation and description and Computer Vision Techniques: Introduction to Morphology, Some basic Morphological Algorithms, Representation, Boundary Descriptors, Regional Descriptors, Chain Code, Structural Methods. Review of Computer Vision applications; Fuzzy-Neural algorithms for computer vision applications 08 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

- Digital Image Processing Rafael C. Gonzalez & Richard E. Woods Pearson Education 3rd edition
- Computer Vision: A Modern Approach David A. Forsyth, Jean Ponce Prentice Hall
- Fundamental of Digital Image Processing A.K. Jain PHI

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	Explain the fundamentals of image processing and computer vision	5
CO2	Illustrate the image enhancement techniques	4
CO3	Illustrate Image restoration and image compression technique	5
CO4	Tell about image segmentation and morphological image processing	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-III			
Embedded Systems and Microcontrollers			
Course Code	22MTR322	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 emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry.

Module-1	
ARM-32 bit Microcontroller:Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
ARM Cortex M3 Instruction Sets and Programming: **ARM Cortex M3 Instruction Sets and Programming:** Assembly basics, Instruction list and description, Thumb and ARM instructions, Special instructions, Useful instructions, CMSIS, Assembly and C language Programming 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Embedded System Components : Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Elements of an Embedded System (Block diagram and explanation), Differences between RISC and CISC, Harvard and Princeton, Big and Little Endian formats, Memory (ROM and RAM types), Sensors, Actuators, Optocoupler, Communication Interfaces (12C, SPI, IrDA, Bluetooth, Wi-Fi, Zigbee only) 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Embedded System Design Concepts : Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co Design and Program Modeling (excluding UML), Embedded firmware design and development (excluding C language). 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
RTOS and IDE for Embedded System Design : Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread pre-emption, Pre-emptive Task scheduling techniques, Task Communication, Task synchronization issues -Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment- Block diagram (excluding Keil), Disassembler/decompiler, simulator, emulator and debugging techniques 08 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

1. Joseph Yiu, ''TheDefinitiveGuidetotheARMCortex-M3", 211d Edition, Newnes, (Elsevier), 2010.
2. 2 Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2"" Edition.

Reference Books:

3. 1. James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008, ISBN: 978-0-471-72180-2.
4. 2. Yifeng Zhu, "Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C", 2"" Ed. Man Press LLC 2015 ISBN: 0982692633 9780982692639.
5. 3. K.V. K.KPrasad, Embedded Real Time Systems, Dreamtech publications, 2003.
6. 4. Rajkamal, Embedded Systems, 211d Edition, McGraw hill Publications, 2010.

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	Describe the architectural features and instructions of 32 bit microcontroller ARM CortexM3.	5
CO2	Apply the knowledge gained for Programming ARM Cortex M3 for different applications.	5
CO3	Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	5
CO4	Develop the hardware software co-design and firmware design approaches	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective			
Advanced Material technology			
Course Code	22MTR323	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 impart knowledge on material selection methods and basics of advanced engineering materials.
To introduce the basics of smart materials, composite materials, ceramics and glasses and modern metallic materials and their applications in engineering.

Module-1	
Classification and Selection of Materials: Classification of materials, properties required in Engineering materials, Selection of Materials; Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Composite Materials:Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Ceramics and Glasses - Bio-ceramics: Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, coatings Physico-chemical surface modification of materials used in medicine. Low & High Temperature Materials: Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Modern Metallic Materials: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides. Non-metallic Materials: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Smart Materials: Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications. Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials. 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**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

1. Engineering Material Technology James A. Jacobs & Thomas F. Kilduff Prentice Hall.
2. Materials Science and Engineering WD. Callister Jr. Wiley India Pvt. Ltd 2010
3. Engineering Design: A Materials and Processing Approach G.E. Dieter McGraw Hill 1991.
4. Materials Selection in Mechanical Design M.F. Ashby Pergamon Press 1992
5. Introduction to Engineering Materials & Manufacturing Processes NIIT Prentice Hall of India
6. Engineering Materials Properties and Selection Kenneth G. Budinski Prentice Hall of India
7. Selection of Engineering Materials Gladius Lewis Prentice-Hall, New Jersey

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
CO 1	Explain the concepts and principles of advanced materials and manufacturing processes.	5
CO 2	Understand the applications of all kinds of Industrial materials.	5
CO 3	Apply the material selection concepts to select a material for a given application.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-III			
Robotics Engineering			
Course Code	22MTR324	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:

1. Have successful professional and technical career
2. Have strong foundation in basic sciences, mathematics and computational platforms
3. Have knowledge on the theory and practices in the field and service of robotics Engineering and allied areas
4. Engross in life-long learning to keep themselves abreast of new developments

Module-1

Introduction: History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Drive systems and Sensors: Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Kinematics and Dynamics of Robots:2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot,Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Robot Control, Programming and Applications: Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT,Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting. 08 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

1.Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Books:

1. S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.
3. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
4.P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

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	To provide an introduction to Robotics and Automation including robot classification, design and selection, analysis and applications in industry.	5
CO2	To provide information on various types of end effectors, their design, interfacing and selection.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-III			
Cyber Physical Systems			
Course Code	22MTR325	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:

1. Students will have an understanding of the cyber physical systems and the corresponding important research challenges in this area.
2. More specifically, one objective is to learn the current state of art in CPS domain.
CPS is multidisciplinary with the need for new underlying principles. Another objective is to learn details regarding several necessary principles required for future CPS.
3. A third objective is improving critical reading, presentation, and research skills.

Module-1	
Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals?, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era: Survival Mantra for the Netizens. Cyberoffenses: How Criminals Plan Them: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Understanding Computer Forensics: Introduction, Historical Background of Cyberforensics, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics. 08 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

1.Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives Sunit Belapure and Nina Godbole Wiley India Pvt Ltd 2013.

2.Introduction to information security and cyber laws Surya Prakash Tripathi, Ritendra Goyal, Praveen Kumar Shukla Dreamtech Press 2015.

Reference Books

1.Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions Thomas J. Mowbray John Wiley & Sons,

2.Cyber Security Essentials James Graham, Ryan Olson, Rick Howard CRC Press 2010

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	Define cyber security, cyber law and their roles	5
CO2	Demonstrate cyber security cybercrime and forensics.	5
CO3	Infer legal issues in cybercrime,	5
CO4	Demonstrate tools and methods used in cybercrime and security.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-IV			
Design Automation with IOT			
Course Code	22MTR/MMD/MDE/MEA/MPM331	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:
1.To assess the vision of IoT.
2. To classify Real World IoT applications in various Domains.
3. To understand design methodology for IoT platforms.

Module-1	
Domain specific IoT: Introduction, Home automation- Smart lighting, smart appliances, intrusion detection, smoke for gas detectors; Cities- Smart Parking, Smart lighting, Smart Roads, Structural Health Monitoring, surveillance, Emergency Response; Environment- Weather monitoring, air pollution monitoring, noise pollution monitoring, forest fire detection, river flood's detection 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Energy- Smart grids, renewable energy systems, prognostics:Retail- Inventory management, smart payments, smart vending machines; Logistics- Route generation and scheduling, Fleet tracking, Shipment monitoring, Remote vehicle diagnostics; Agriculture- Smart Irrigation, Green house control; Industry- Machine diagnosis and prognosis, indoor air Quality monitoring; Health and Life Style- Health and fitness monitoring, Wearable electronics. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
IoT and M2M : Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT- Software defined networking, network function virtualization; 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
IoT Platforms Design Methodology : Introduction, IoT Design and Methodology- Purpose and requirements specification, Process specification, Domain model specification, Information model specification, service specification, IoT level specification, functional view specification, Operational view specification, Device and component integration, application development. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
IoT Physical Devices and Endpoints : What is an IoT device? , Basic Building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, Other IoT devices. 08 Hrs	
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**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

1.Internet of Things – A Hands on Approach, By Arshdeep Bahga and Vijay Madisetti Universities Press, ISBN: 9788173719547 (Unit I to V)

2. Designing the Internet of Things – Adrian McEwen & Hakim Cassimality Wiley India, ISBN: 9788126556861 (Unit VI)

References

1.The Internet of Things – Key Applications and Protocols, Wiley Publication, Olivier Hersent, David Boswarthick, Omar Elloumi. ISBN: 9788126557653

2. The Internet of Things , Pearson, By Michael Miller ISBN: 9789332552456

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	Interpret the vision of IoT from a global context	5
CO2	Illustrate the application of IoT in various Domains.	3
CO3	Understand the differences and Similarities between IoT and M2M.	5
CO4	Interpretation of different IoT platforms design methodology.	3
CO5	Illustration of IoT Physical Devices.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-IV			
Finite Element Method			
Course Code	22MTR332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To learn the theory and characteristics of finite elements that represent engineering structures.
2. 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.

Module-1

Introduction to finite element method: basic steps in finite element method to solve mechanical engineering problems (solid, fluid and heat transfer). Functional approach and Galerkin approach. Displacement approach: admissible functions. **Convergence criteria:** conforming and nonconforming elements, C0, C1 and Cn continuity elements. Basic equations, element characteristic equations, assembly procedure, boundary and constraint conditions.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Solid Mechanics: One-dimensional finite element formulations and analysis – bars- uniform, varying and stepped cross section. Basic (Linear) and higher order elements formulations for axial, torsional and temperature loads with problems. **Beams-** basic (linear) element formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions, numericals.
Trusses, Plane frames and Space frame – basic (Linear) elements formulations for different boundary conditions -axial, bending, torsional, and temperature loads, numericals.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Two-dimensional finite element formulations for solid mechanics problems: triangular membrane (tria 3, tria 6, tria 10) element, four noded quadrilateral quad membrane 4, quad 8) element formulations for in-plane loading with simple problems. Triangular and quadrilateral axi-symmetric basic and higher order elements formulation for axi-symmetric loading with simple numericals.
Three-dimensional finite element formulations for solid mechanics (only Introduction no Numericals): finite element formulation of tetrahedral element (tet 4, tet 10), hexahedral element (hexa 8, hexa 20), for different loading conditions. Serendipity and Lagrange family elements

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Trusses, Plane frames and Space frame – basic (Linear) elements formulations for different boundary conditions -axial, bending, torsional, and temperature loads, numericals.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Dynamic analysis: finite element formulation for point/lumped mass and distributed masses system, finite element formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element.

05 Hrs

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**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

(1) Introduction to Finite Elements in Engineering, T. R. Chandrupatla and A. D. Belegundu, Prentice Hall, 3rd Ed, 2002.
(2) Finite Elements Analysis– Procedures in Engineering, Lakshminarayana H. V., Universities Press, 2004.

Reference Books

(1) Finite Elements Method in Engineering, Rao S. S, 4th Edition, Elsevier, 2006
(2) Textbook of Finite Element Analysis, P. Seshu, PHI, 2004.
(3) Introduction to Finite Element Method, J.N.Reddy, McGraw -Hill, 2006.
(4) Finite Element Modelling for Stress Analysis, Cook R. D., Wiley,1995.

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 concepts of Variation methods and weighted residual methods.	4
CO2	Identify the application and characteristics of FEA elements such as bars, beams, plane and isoperimetric elements, and 3D element.	4
CO3	Develop element characteristic equations and generate global stiffness equations.	5
CO4	Apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.	4
CO5	Identify how the finite element method expands beyond the structural domain, for problems involving dynamics and heat transfer.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective-IV			
Virtual Instrumentation			
Course Code	22MTR333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Gain knowledge to learn the concepts of developing basic skills necessary for importance Virtual Instrumentation and Lab View
2. Understand the basic programming concepts and various Operation using DAQ Devices used in Virtual Instrumentation and Lab View.
3. Diagnosis the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.

Module-1

CONCEPT OF VIRTUAL INSTRUMENTATION – Concepts of Instrumentation and Measurements Historical perspective – Need of VI – Advantages of VI – Define VI – Block diagram & Architecture of VI – Data flow techniques – Graphical programming in data flow -Comparison with conventional programming. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

DATA ACQUISITION BASICS: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution Data acquisition interface requirements. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

PC based data acquisition – Typical on board DAQ card – Resolution and Sampling , Sampling Theorem sampling frequency – Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multichannel analog inputs. Concept of universal DAQ card

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

CLUSTER OF INSTRUMENTS IN VI SYSTEM: Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus.05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

USE OF ANALYSIS TOOLS AND APPLICATION OF VI: Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system – Generation of HTML page.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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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

1. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
2. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003
3. PC Interfacing for Data Acquisition and Process Control & S.Gupta and JP Gupta InstrumentSocietyofAmerica,1994
4. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

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	Gain knowledge to learn the concepts of developing basic skills necessary for importance Virtual Instrumentation and Lab View, Understand the basic programming concepts and various Operation using DAQ Devices used in Virtual Instrumentation and Lab View.	5
CO2	Diagnosis the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.	5
CO3	Build applications employed in various debugging techniques, simulating and analyzing the data and use general purpose interface bus and Serial communication Interface.	5
CO4	Create applications that uses plug in DAQ boards and built in analysis functions to process the data.	5
CO5	Design and analyse various applications on Real time monitoring using DAQ boards	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

Professional Elective 4			
Reliability and Failure Analysis			
Course Code	22MTR334	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:

Gain the knowledge and tools needed to design for reliability and conduct an engineering investigation to assess potential sources, causes and solutions for failure prevention and analysis.

Module-1	
Introduction Quality and Reliability, Industry practices of FA and reliability engineering, Common failure types Mechanical Fracture, Fracture mechanics, Fatigue, Delamination 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Corrosion Induced Failure, General wear, Galvanic corrosion, Stress Corrosion Cracking, 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Reaction and Diffusion Induced, Electromigration, Thermomigration, Whisker growth in Sn. 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Statistical Analysis of Failure, Basics of statistics, Normal, Weibull and log-normal distribution, Statistical modeling of failure 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Examples of failure analysis, Electromigration in IC devices, fatigue analysis of solder joints for IC package, Case of twin-tower 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**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

1. Quality Planning and Analysis - Tata McGraw - Juran, J.M and Gryna, F.M. - Hill publishing Coimpany Ltd., New Delhi, India –1982.
2. Maintainability and Reliability Handbook of Reliability Engineering and Management - Editors –Ireson. W.G. and Cooms- C.F. McGraw - Hill Book Company Inc. –1988.
3. Concepts in Reliability Engineering- Srinath L S - Affiliated East-West Press Private Limited, New Delhi, India. –1985.

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
CO 1	Explain terminology used for reliability engineering, risk and failure analysis	4
CO 2	Critically evaluate failure modes and root causes	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
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Mapping of COS and POs

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

Professional Elective 4			
Product Design and Development			
Course Code	22MTR/MEM335	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 main objective of the course is to acquaint the learners/students with the practical knowledge regarding conceptualization, design and development of a new product.

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, the AMF development process, product development organizations, the AMF organization.
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.

10 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

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. 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, reflect on the results and the process.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

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, reflect on the results and the process.
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.

08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Industrial design:
Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.
Design for Manufacturing:
Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.
Prototyping:
Prototyping basics, principles of prototyping, technologies, planning for prototypes.

08Hrs

Teaching-Learning	Chalk and talk method / PowerPoint Presentation

Process	

Module-5

Product Development Economics:
Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Managing Projects:
Understanding and representing task, baseline project planning, accelerating projects, project execution, post mortem project evaluation.

06 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

1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.

REFERENCE BOOKS:

1. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
2. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997
3. Product Design for Manufacture and Assembly - GeofferyBoothroyd, Peter Dewhurst and Winston Knight - 2002

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
CO 1	Development Processes and Organizations	5
CO 2	Identifying Customer Needs	4
CO 3	Product Architecture	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.	
PO2	Build Prototype, Test Analyze and Interpret the Results.	
PO3	Design Mechatronic Systems, Processes or Products.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	

Mapping of COS and POs

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

PROJECTWORK PHASE–1			
Course Code	22MTR34	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning 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.
- Developinteractive,communication,organisation,timemanagement,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 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate them ethodology to carry out the projectwork.

Seminar: Each student,under the guidance of a Faculty,is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach highstandards and become self-confident.

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 utilizing 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 for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded(based on the quality of report and presentation skill, participation in the question and answer session by the student)by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

SOCIETAL PROJECT			
Course Code	22MTR35	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning 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 instill responsibilities to one self 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.

Societal-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide,co-guide,and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the societal –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.

CIE procedure for Societal - Project:

The CIE marks awarded for Mini-Project, shall be based on the evaluation of Societal- Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Societal - Project report shall be the same for all the batch mates.

INTERNSHIP			
Course Code	22MTRI36	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(06 weeks Internship,To be Completed during the intervening vacation of II and III semesters.)	SEE Marks	50
Total Hours of Pedagogy	--	Total Marks	100
Credits	06	Exam Hours	03

Course Learning 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 objective are further,

1. To put theory into practice.
2. To expand thinking and broaden the knowledge and skills acquired through coursework in the field.
3. To relate to, interact with ,and learn from current professionals in the field.
4. To gain a greater understanding of the duties and responsibilities of a professional.
5. To understand and adhere to professional standards in the field.
6. To gain insight to professional communication including meetings,memos,reading,writing,publicspeaking,research,clientinteraction,inputofideas, and confidentiality.
7. To identify personal strengths and weaknesses.
8. To develop the initiative and motivation to be a self-starter and work independently.

Internship/Professionalpractice: Students under the guidance of internal guide/sand externalguide shall take part in all the activities regularly to acquire as much knowledgeaspossiblewithoutcausinganyinconvenienceattheplaceofinternship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through powerpoint 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.

Continuous Interna lEvaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (20 marks) and question and answer session (10marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

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

PROJECTWORK PHASE-2			
Course Code	22MTR41	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:0:8	SEE Marks	100
Total Hours of Pedagogy	--	Total Marks	200
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,timemanagement,andpresentationskills.
- 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 in still responsibilities to one self and others.
- To train students to present the topic of project work in a seminar without anyfear,face audience confidently,enhance communication skill,involve ingroup discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly inconstant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Courseoutcomes:

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 kills
- Communicateeffectivelyandtopresentideasclearlyandcoherentlyinboththewrittenandoralforms.
- Work in a team to achieve common goal.
- Learn on their own,reflecton their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 50 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report.To be awarded by the internal guide in consultation with external guide if any.

Project Presentation:30marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 20marks.

The student shall be evaluated based on the ability in the Question and Answer session.

Semester End Examination

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