Open Electives – II offered by the Department to other Department students			
21MT751	Concepts of Mechatronics system design	21MT754	Introduction to Smart Factory and Industry4.0
21MT752	Virtual instrumentation	21MT755	Robotics for Industry
21MT753	PLC and SCADA Technology		

Note: PCC: Professional Core Course, **PEC:** Professional Elective Courses, **OEC**–Open Elective Course, **AEC** –Ability Enhancement Courses.
L –Lecture, T – Tutorial, P- Practical / Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Note: VII and VIII semesters of IV year of the programme

(1) Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester**.**

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the programme.

PROJECT WORK (21XXP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.
(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.
(iii) To impart flexibility and adaptability.
(iv) To inspire team working.
(v) To expand intellectual capacity, credibility, judgment and intuition.
(vi) To adhere to punctuality, setting and meeting deadlines.
(vii) To instill responsibilities to oneself and others.
(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

TECHNICAL SEMINAR (21XXS81): The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

(i) Carry out literature survey, systematically organize the content.
(ii) Prepare the report with own sentences, avoiding a cut and paste act.
(iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
(iv) Present the seminar topic orally and/or through PowerPoint slides.
(v) Answer the queries and involve in debate/discussion.
(**vi)** Submit a typed report with a list of references.

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

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks
Presentation skill:25 marks
Question and Answer: 25 marks.■ No SEE component for Technical Seminar

Non – credit mandatory courses (NCMC):

National Service Scheme/Physical Education (Sport and Athletics)/ Yoga:

(1) Securing 40 % or more in CIE,35 % or more marks in SEE and 40 % or more in the sum total of CIE + SEE leads to successful completion of the registered course.

(2) In case, students fail to secure 35 % marks in SEE, they has to appear for SEE during the subsequent examinations conducted by the University.

(3) In case, any student fails to register for NSS, PE or Yoga/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have not completed the requirements of the course. In such a case, the student has to fulfill the course requirements during subsequently to earn the qualifying CIE marks subject to the maximum programme period.

(4) Successful completion of the course shall be indicated as satisfactory in the grade card. Non-completion of the course shall be indicated as Unsatisfactory.

(5) These course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES			
Course Code	**21MAT 31**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT 31 is:

CLO 1. To have an Insight into solving ordinary differential equations by using Laplace transform techniques

CLO 2. Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.

CLO 3. To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.

CLO 4. To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourse outcomes.

1. Inadditiontothetraditionallecturemethod,differenttypesofinnovativeteachingmethodsmay be adopted so that the delivered lessons shall develop students' theoretical and applied mathematicalskills.
2. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
3. Supportandguidethestudentsforself–study.
4. Youwillalsoberesponsibleforassigninghomework,gradingassignmentsandquizzes,and documenting students'progress.
5. Encouragethestudentsforgrouplearningtoimprovetheircreativeandanalyticalskills.
6. Showshortrelatedvideolecturesinthefollowingways:
   - Asanintroductiontonewtopics(pre-lectureactivity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - Asanadditionalmaterialofchallengingtopics(pre-andpost-lectureactivity).
   - Asamodelsolutionforsomeexercises(post-lectureactivity).

Module-1: Laplace Transform	**8 HOURS**

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations.

Self-study: Solution of simultaneous first-order differential equations.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series	**8 HOURS**

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy'sroot test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Infinite Fourier Transforms and Z-Transforms	**8 HOURS**

Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.

Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations.

Self Study: Initial value and final value theorems, problems.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations **8 HOURS**

Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method, Solution of the Wave equation. Problems.

Self Study: Solution of Poisson equations using standard five-point formula.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations **8 HOURS**

Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).

Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems

Self Study: Hanging chain problem

(RBT Levels: L1, L2 and L3)

Course outcomes: After successfully completing the course, the students will be able:

- **CO1.** To solve ordinary differential equations using Laplace transform.
- **CO2.** Demonstrate the Fourier series to study the behavior of periodic functions and their applications in system communications, digital signal processing and field theory.
- **CO3.** To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- **CO4.** To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- **CO5.** Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. **B.S.Grewal**:"HigherEngineeringMathematics",Khanna publishers,44th Ed.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10th Ed.(Reprint),2016.

Reference Books

1. **V.Ramana:**"HigherEngineeringMathematics"McGraw-HillEducation,11th Ed.
2. **SrimantaPal&SubodhC.Bhunia:**"EngineeringMathematics"OxfordUniversityPress,3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.DassandEr.RajnishVerma:**"HigherEngineeringMathematics"S.ChandPublication(2014).
7. **JamesStewart:"**Calculus"Cengagepublications,7th edition,4th Reprint2019.

Web links and Video Lectures (e-Resources):

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

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

- Quizzes
- Assignments
- Seminars

ANALOG AND DIGITAL ELECTRONICS(IPCC)			
Course Code	**21MT32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:1	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course Learning objectives:

CLO 1. Understand the operation and Learn the Design of Opamp Active Filters.

CLO 2. Understand the Working Principle and Design of Oscillators and Comparators.

CLO 3. Understand the Working Principle and Design of 555 timers and Its applications.

CLO 4. Understand the operation and Design of Combinational Logic.

CLO 5. Understand the Working Principle and Learn the Design of Sequential Logic.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method(L)does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Arrange visits to nearby PSU such as BHEL, BEL, ISRO, etc .and small-scale hardware industries to give brief information about the electronics manufacturing Industry.
3. Show Video/animation films to explain the functioning of various analog and digital circuits.
4. Encourage collaborative (Group)Learning in the class
5. Ask at least three HOTS(Higher-order Thinking)questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL),which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

MODULE-1 **8 HOURS**

Op-Amp active filters: Introduction, Active filters, I order low pass filter, Design, frequency scaling,II order low pass filter: Design, I order high pass filters: Design, II order high pass filters: Design, Band Pass Filter: wide Band pass filter, Band reject filter: wide Band reject filter.

Text 1: Chapter 7

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Animation of input and output waveforms of the Filter circuits. Self-study topics: Types of Clippers, Clampers, Amplifier Operation.

MODULE-2 **8 HOURS**

Oscillators and Comparators:

Oscillators: Oscillator Principles, Types, Frequency Stability, RC Phase shift oscillator, Wein bridge oscillator. Problems.

Comparators: Basic Comparators, Non-Inverting Comparator, Inverting Comparator, Zero Crossing Detector, Schmitt Trigger, Derivation for Hysteresis Voltage. Problems.

Text1: Chapter 7 and 8.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Laboratory Based Learning. Self-study topics: Applications of Comparators, Oscillators and Op Amps.

MODULE-3 **8 HOURS**

555 timers and Its applications:

Introduction, the 555-timer Pin diagram, Architecture of 555 timers, 555 timer as Monostablemultivibrator, 555 Timers as Astablemultivibrator, Derivation for Percentage Duty cycle. Applications of AstableMultivibrator: Square Wave Oscillator. Applications of MonostableMultivibrator: Frequency Divider Problems.

Text1: Chapter 9

Teaching-Learning Process	Chalk and talk method, Power Point Presentation, YouTube videos. Self-Study topics: Design of 555 timers for various Real-time applications.

MODULE-4 **8 HOURS**

Combinational Logic: Introduction to K-Maps: 2, 3 and 4 variable maps.Adders: Half adder and Full adder.Subtractor: Half subtractor and Full subtractor.Multiplexers: 4:1 multiplexer, Quadruple 2 to 1 line multiplexer, Boolean functionImplementation.Demultiplexers: 1:4 Demux, Implementation using decoder,Encoders: Octal to binary encoder.Decoders: 3-to-8-line decoder, BCD to Decimal decoder and 4X16 Decoder. **Text2: Chapter 3 and 5.**	
Teaching-Learning Process	Chalk and talk method, Power Point Presentation, YouTube videos. Self-study topics :VLSI Fabrication of Combinational Circuits.
MODULE 5	**8 HOURS**
Sequential Logic: Introduction, Flip flops: Basic circuits, RS flip flop, D-flipflop,clocked D-flip-flop, JK flip flop, clocked JK flip-flop, T-flip-flop, clocked T-flip-flop, Counters: Synchronous counter-Design of 3 Bit Binary Up counter. **Text 2: Chapter 6.**	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos Self-study topics: VLSI Fabrication of Sequential Circuits.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Design and Rig up a Shunt Clipper circuit to limit the Positive Peak Voltage to +2V,Negative Peak Voltage to -2V and and Double Ended Clipper to limit output voltage to +4v and -4v.
2	Design and Rig up a circuit to Realize the operation of Positive and Negative Clampers.
3	Design and Rig up a circuit to Realize the operation of Inverting, Non-Inverting Amplifier and Voltage Follower using Op-Amp.
4	Design and Rig up a circuit to Realize the operation of 555 Timer as Monostable and AstableMultivibrator.
5	Simplification of Boolean Expression using K-maps and Realization of Simplified Boolean Expression using Basic Gates and Universal Gates.
6	Realization of Half Adder and Full Adder using Basic Gates ,Universal Gates and Verify its Truth Table of Operation.
7	Rig up a circuit using IC 74153 and Verify Truth Table of Operation of Multiplexer.
8	Rig up a circuit using IC 74139 and Verify Truth Table of Operation of Demultiplexers.
9	Rig up a circuit using IC 74147 and Verify Truth Table of Operation of Encoders
10	Rig up a circuit using IC 7447 and Verify Truth Table of Operation of Decoders.
11	Rig up a circuit using IC 7495 ,IC7404 and Verify Truth Table of Operation of Ring Counter and Johnson Counter
12	Rig up a circuit using IC 7490 and Verify Truth Table of Operation of Mod-7 Counter.
13	Rig up a circuit using IC 7490, IC7410 and Verify Truth Table of Operation of Decade Counter.

Course outcomes (Course Skill Set):

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

CO1. Understand the working principle of Analog & Digital Electronic Circuits.

CO2. Understand the characteristics & response of Analog & Digital Electronic Circuits.

CO3. Formulate the relations for Voltage Gain, Frequency of Various Analog Electronic Circuits & Boolean Expressions for Digital Electronic Circuits.

CO4. Design the Analog & Digital Electronic Circuits for Required Specifications.

CO5. Design and conduct the experiment on clippers ,clampers, amplifiers, 555 timers for the design specifications.

CO6. Design and conduct the experiment to verify the truth table operation of combinational and sequential circuit**.**

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

1. The question paper will have ten questions. Each question is set for 20 marks.
2. 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.
3. 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 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

TextBooks:

1. "Opamp and Linear Integrated Circuits", Ramakant A Gayakwad 3rd edition, PHI.
2. "Digital Logic and Computer Design", M Morris Mano, 2001 edition, PHI.

Reference Books:

1. "Digital Electronics: Principles and Integrated circuits", Anil K Maini, 2008, wiley India.
2. "Linear Integrated Circuits", D. Roy Choudhury and Shail B Jain, 2nd edition, Reprint 2006, New Age International.
3. "Digita l Principles and applications", Malvino& Leach, Tata Mc. Graw Hill.

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

- Group activities
- Presentations
- Quiz

MATERIAL SCIENCE AND MANUFACTURING TECHNOLOGY (IPCC)			
Course Code	**21MT33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

Thecoursewillenablethestudentsto

CLO1. To understand the structure, behaviour and properties of engineering materials.
CLO2. Tounderstand processing and types of composite materials and ceramics.
CLO3. To provide adequate knowledge of Manufacturing technology and casting.
CLO 4. To provide knowledge of various welding process in manufacturing
CLO 5. To introduce students to different machine tools to produce components having different shapes and sizes.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Introduction to Crystal Structure: Coordination number, atomic packing factor, Simple Cubic, BCC,FCC and HCP Structures, Crystal imperfections–point, line, surface and volume imperfections. Atomic Diffusion: Phenomen on, Fick's laws of diffusion (First and Second Law); Factors affecting diffusion.

Mechanical Behavior: Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering stress and true strains, Linear and non- linear elastic behavior and properties, Mechanical properties in plastic range: Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness. Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals.

Teaching-Learning Process	1. Power-pointPresentation, 2. VideodemonstrationorSimulations, 3. ChalkandTalkareusedforProblemSolving. LaboratoryDemonstrationsandPracticalExperiments

MODULE-2 **8 HOURS**

Composite materials: Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Fundamentals of production of composites, hybrid composites. Applications of composite materials.

Smart Materials: Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magnetoelectric Materials. Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, Fiber-Optic Sensors.

Teaching-Learning Process	1. PowerPointPresentation, 2. Videodemonstration. 3. ChalkandTalkareusedforProblemSolving. 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-3 **8 HOURS**

Introduction to Manufacturing Process: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. **Casting:** Introduction to Casting process &steps involved. Various components produced by casting process, Advantages &Limitations. **Melting furnaces:** Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. **Casting using metal moulds:**Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.	
Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. Videodemonstration
MODULE-4	**8 HOURS**
Welding process: Definition, Principles, classification, application, advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW). **Special types of welding**: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.	
Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk. 3. Videodemonstration,
MODULE 5	**8 HOURS**
Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications. **Introduction to basic metal cutting machine tools:** Lathe- Parts of lathe machine, accessories of lathe machine, and various operations carried out on lathe. **Milling:**Various Milling operations, classification of milling machines, Vertical & Horizontal milling, up milling& down milling. Indexing: need of indexing, simple, compound & differential indexing. **Drilling**: Difference between drilling, boring & reaming, types of drilling machines. Boring operations & boring machines.	
Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk 3. Videodemonstration, 4. LaboratoryDemonstrationsandPracticalExperiments

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments (13 experiments)
1	To determine the tensile strength of the metallic specimen using Universal Testing Machine.
2	To determine the compressive strength of the metallic specimen using Universal Testing Machine
3	To determine the shear strength of the specimen using Universal Testing Machine
4	To determine the torsional strength of the specimen.
5	To determine Maximum Bending Moment on Non-metallic specimens.
6	To determine Impact strength of the specimen using Izod impact testing machine.
7	To determine Impact strength of the specimen using Charpy impact testing machine.
8	To determine the hardness of the specimen using Brinell hardness setup
9	To determine the hardness of the specimen using Rockwell hardness setup

10	To Study of Microstructure of the metallic specimen using optical Microscope.
11	Demonstration of one model on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling.
12	Demonstration of one model models on Milling Machine involving Upmilling, Downmilling and Indexing
13	Demonstration of Drilling and shaping Operation.

Course outcomes (Course Skill Set):

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

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

CO 1. Understand mechanical properties of metals, alloys and composites.

CO 2. Describe the process of casting, different methods to process composite materials.

CO 3. Determine the mechanical properties of given materials through material testing experiments

CO 4. Develop components of different shapes involving conventional machining operations

CO 5. Prepare/ develop a physical model by performing different machining operations

CO 6. Determine the mechanical properties of given materials and visualize the micro structure of the specimen

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum

of 3 sub-questions), **should have a mix of topics** under that module.

- The students have to answer 5 full questions, selecting one full question from each module.

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

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Materials Science and Engineering, William D. Callister Jr., John Wiley & Sons. Inc, 5th Edition, 2001.
2. Mechanics of Composite Materials, Second Edition, Autar K. Kaw, CRC Press, 2005.
3. Smart Materials and Structures - M. V. Gandhi and B. So Thompson - Chapman & Hall, London; New York - 1992 (ISBN: 0412370107).
4. Principles of metal casting Rechard W. Heine, Carl R. Loper Jr., Philip C. Rosenthal Tata McGraw Hill Education Private Limited 1976

Reference Books:

1. An Introduction to Metallurgy; Alan Cottrell, Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. "Manufacturing Technology Serope"KalpakjianSteuen. R Sechmid Pearson Education Asia 5th Ed. 2006

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

1. Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. Preparation of two models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling.

MECHANICS OF SOLID AND FLUIDS			
Course Code	21MT34	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

Thecoursewillenablethestudentsto

CLO1. Gain knowledge of linear elastic properties and stress strain relations.

CLO2. Derive and solve problems on Principal stresses developed in structures.

CLO3. Compute the stress strain for bars, beams, shafts, and column and to apply the concept of dynamic similarity and to apply it to experimental modelling.

CLO 4. Gain knowledge of basic properties of fluids, fluid statics.

CLO 5. To apply conservation of mass, momentum and energy equation and to determine the discharge of fluid flow.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.
3. Adoptcollaborative(GroupLearning)Learningintheclass.
4. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation.
5. ConductLaboratoryDemonstrationsandPracticalExperimentstoenhance experientialskills.

Module-1

8 hours

Simple Stress and Strain: Introduction, Concept of Stress and Strain, Linear elasticity, Hooke's Law and Poisson's ratio. Extension / Shortening of a bar, bars with varying cross sections (step and tapering circular and rectangular), Elongation due to self-weight, Principle of super position, St. Venant's Principle**.**
Simple shear stress and Shear strain. Volumetric strain: expression for volumetric strain, Elastic Constants and relations. Stresses in Composite Section

Teaching-Learning Process	1. Power-pointPresentation. 2. VideodemonstrationorSimulations. 3. ChalkandTalkareusedforProblemSolving. LaboratoryDemonstrationsandPracticalExperiments.

Module-2

8 hours

Compound Stresses: Introduction, Concept of Plane stress, Stress tensor for plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.

Teaching-Learning Process	1. PowerPointPresentation, 2. VideodemonstrationorSimulations, 3. ChalkandTalkareusedforProblemSolving. 4. LaboratoryDemonstrationsandPracticalExperiments

Module-3

8 hours

Torsion of Circular Shafts: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.
Elastic Stability of Columns: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula.

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. VideodemonstrationorSimulations. 4. LaboratoryDemonstrationsandPracticalExperiments

Module-4

8 hours

Introduction to Fluid mechanics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc., pressure at a point in the static mass of fluid, variation of pressure. Pascal's law, absolute, gauge, atmospheric and vacuum pressures; pressure measurement by simple, differential manometers and mechanical gauges.
Fluid Statics: Total pressure and centre of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.

Teaching-Learning	1. PowerPointPresentation. 2. ChalkandTalkareused.

Process	3. LaboratoryDemonstrations.

Module-5

8 hours

Fluid Kinematics: Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational &irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flow net.

Fluid Dynamics; Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline. Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation. Major head loss (frictional), Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi-meter, orifice meter, rectangular and triangular notch, pitot tube.

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. Videodemonstration. 4. LaboratoryDemonstrationsandPracticalExperiments

Course outcome (Course Skill Set)

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

CO 1. Gain the knowledge of properties, and stress-strain relations in linear elastic solid members and fluids. To understand the concepts of fluid statics, kinematics and dynamics.

CO 2. Describe stress-strain equation for axial, bending and torsion loads while addressing problems in engineering.

CO 3. Apply the concepts of fluid statics, kinematics and dynamics while addressing problems in engineering and to determine the fluid flow through open and closed channel.

CO 4. Determine the stress & strain for simple stresses, compound stresses, shafts & columns.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. "Mechanics of Materials", by R.C.Hibbeler, Prentice Hall. Pearson Edu., 2011.
2. "Mechanics of materials", James.M.Gere, Thomson, Eighth edition2013.
3. "Mechanics of materials", in SI Units, Ferdinand Beer & Russell Johston, 5th Ed., TATA McGraw Hill- 2003.
4. A Text Book of Fluid Mechanics and Hydraulic Machines" Dr R.K Bansal Laxmi Publishers.
5. "Fluid Mechanics (SI Units)" Yunus A. Cengel John M.Cimbala, TataMcGraw Hill 3rd Ed.,2014.

Reference Books:

1. "Strength of Materials", S.S. Rattan, Tata McGraw Hill, 2009.
2. "Strength of Materials", S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. "Engineering Mechanics of Solids", Egor.P. Popov, Pearson Edu. India, 2nd, Edition, 1998.
4. "Strength of Materials", W.A. Nash, 5th Ed., Schaum's Outline Series, Fourth Edition-2007.
5. "Fluid Mechanics" F M White, McGraw Hill Publications Eighth Edition.
6. "Introduction to Fluid Mechanics" Fox, McDonald John, Wiley Publications 8th edition.

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

- Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, grey C.I, SG iron, Brass, Bronze & composites.
- Tensile, shear and compression tests of steel, aluminium and cast iron specimens using Universal Testing Machine
- Torsion Test on steel bar. andIzod and Charpy Tests on Mild steel and C.I Specimen.
- Determination of coefficient of friction of flow in a pipe.
- Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades.
- Calibration of flow measuring devices.

MACHINE DRAWING AND GD & T			
Course Code	**21MTL35**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	03
* One additional hour may be considered wherever required			

Course objectives:

CLO 1. To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.

CLO 2. To make drawings using orthographic projections and sectional views

CLO 3. To impart knowledge of thread forms, fasteners, keys, joints, couplings and clutches.

CLO 4. To understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.

Module 1 (only for CIE) **01 Sessions**

Review of basic concepts of Engineering Visualization

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

Module 2 (only for CIE) **02 Sessions**

Sections of Simple and hollow solids: True shape of sections.

Module 3 (only for CIE) **03 Sessions**

Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread, Helicoil thread inserts

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, countersunk head screw, grub screw, Allen screw

Rivets

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.

Module 4 **03 Sessions**

Assembly of Joints, couplings and clutches (with GD&T)using 2D environment

Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

Couplings: Like flanged coupling, universal coupling

Clutches: Like Single Plate clutch, cone clutches

Module 5 **05 Sessions**

Assembly of Machine Components (with GD&T) using 3D environment

(Part drawings shall be given)

1. **Bearings**
2. **Valves**
3. **Safety Valves**
4. **I.C. Engine components**
5. **Lifting devices**
6. **Machine tool components**
7. **Pumps**

Course outcomes (Course Skill Set):

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

CO1. Interpret the Machining and surface finish symbols on the component drawings.

CO2. Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.

CO3. Illustrate various machine components through drawings

CO4. Create assembly drawings as per the conventions.

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 40% of the maximum marks (20 marks) and that for SEE minimum passing mark is 35% of the maximum marks (18 marks). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
    - Continuous evaluation of Drawing work of students as and when the Modules are covered.
    - At least one closed book **Test** covering all the modules on the basis of below detailed weightage.
    - ***Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators***.

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module 1	10	05	05
Module 2	15	10	05
Module 3	25	20	05
Module 4	25	20	05
Module 5	25	25	00
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours**. Questions shall be set worth of 3 hours**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule. **Questions are to be set preferably from Text Books.**
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: *To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.*
- One full question shall be set from Modules 3 and 4 as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch***.

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module 4	40	30	10
Module 5	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books:

- K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
- N D Bhatt , "Machine Drawing", Charotar Publishing House Pvt. Ltd.,50th Edition, ISBN-13: 978-9385039232, 2014

Reference Books:

- Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd, 2nd Edition, ISBN: 9788120346796, 2012
- Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

Programming in C++			
Course Code	**21MT381**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	1	Exam Hours	1

Course Learning Objectives:

CLO 1. Understand overview of C++ and basic C++ syntax

CLO 2. Classify data types and differentiate identifiers, constants and variables

CLO 3. Make use of operators to solve programs

CLO 4. Identify iteration statement and jump statements

CLO 5. Identify methods to create and manipulate array

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it

Module-1	
Introduction to Object Oriented Programming: Computer programming background- C++ overview First C++ Program -Basic C++ syntax. Advantages, disadvantages and applications.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Module-2	
Expressions: Five basic data types, modifying data types, identifier names, constants, variable initialization, order of evaluation, spacing and parentheses.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Module-3	
Operators: Assignment operator, type conversion in assignments, multiple assignments, arithmetic operators, increment and decrement operator, relational and logical operator, bitwise operator.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Module-4	
Statements: True and false in C and C++, selection statements, iteration statements, declaring variables within selection and iteration statements, jump statements.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Module-5	
Arrays: Single dimension array, generating pointers to an array, passing single dimension array to function, two-dimensional array, multi-dimensional array.	
Teaching-Learning Process	Chalk and board, Active Learning, practical based learning

Course outcome (Course Skill Set)

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

CO 1. Understand basics of C++ and classify data types

CO 2. Demonstrate proficiency in handling operators and statements to solve programs

CO 3. Identify the methods to create and manipulate arrays

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Herbert Schildt, C++ The Complete Reference, 4th Edition, Tata McGraw Hill
2. Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, Second Edition, 2012.
3. Balagurusamy E, Object Oriented Programing with C++IITata McGraw Hill Education Pvt.Ltd , Fourth Edition 2010.

Reference Books:

1. Bhave , " Object Oriented Programming With C++", Pearson Education , 2004.

2. Ray Lischner, "Exploring C++ : The programmer‟s introduction to C++" , apress, 2010 Bhave , " Object Oriented Programming With C++", Pearson Education , 2004

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

- Group activity
- Presentation
- Quiz

Trends in Digital Manufacturing			
Course Code	**21MT382**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	1	Exam Hours	1

Course Learning Objectives:

CLO 1. To understand the basic design process and Product life cycle

CLO 2. To know the steps involved in Computer sided design

CLO 3. To understand basics of Additive manufacturing

CLO 4. To gain knowledge on different additive manufacturing techniques

CLO 5. To know the process of Reverse Engineering

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Using different ICT tools in teaching
2. Encourage collaborative(Group)Learning in the class
3. Ask at least three HOTS (Higher-order Thinking)questions in the class, which promotes critical thinking
4. Adopt Problem Based Learning(PBL),which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

Module-1

Design processes and methods, Introduction to CAD/CAM/CAE technologies and product lifecycle management (PLM).

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-2

Computer Aided Design (CAD): applications of computers in design, software configuration, functions of graphics package, constructing the geometry.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-3

Additive manufacturing- General methodology, stages and components of the process. Main technologies, principles and applications. Strengths, weaknesses, challenges, and limitations of additive manufacturing technologies.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-4

Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-5

Reverse Engineering-applications and selection of reverse engineering systems. Hardware and software involved.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Course outcome (Course Skill Set)

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

CO 1. To understand the meaning of digital manufacturing, and different techniques involved in it

CO 2. To describe the digital manufacturing techniques in reverse engineering

CO 3. To apply the knowledge of additive manufacturing process in choosing particular method.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Book

1. Automation, Production Systems and Computer-Integrated Manufacturing Mikell P Groover Pearson Learning, 4th Edition,2015
2. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker 2nd Ed. (2015)
3. CAD / CAM Principles and Applications P N Rao Tata McGraw-Hill 3rd Edition, 2015
4. CAD/CAM Ibrahim Zeid Tata McGraw Hill,
5. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011

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

- Group task
- Quiz
- Projects on 3D Printers

MECHATRONICS ECOSYSTEM			
Course Code	**21MT383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100

Credits	1	Exam Hours	1

Course Learning Objectives:

CLO 1. To introduce the functional elements of mechatronics systems

CLO 2. To impart knowledge on Building blocks of Mechatronics system and Measurement system.

CLO 3. To know about different types of control systems in Mechatronics.

CLO 4. To educate on various concepts in Mechatronics system configuration.

CLO 5. To understand different mechatronics systems through case study

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Show Video/animation films to explain the functioning of elements of Robotics
2. Encourage collaborative(Group)Learning in the class
3. Ask at least three HOTS (Higher-order Thinking)questions in the class, which promotes critical thinking
4. Adopt Problem Based Learning(PBL),which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

Module-1

Definition of mechatronics, functional elements of mechatronics systems. The roots of mechatronics, Mechatronics system configuration.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-2

Building blocks of Mechatronics system. Difference between conventional and mechatronics design system approach, elements in mechatronics measurement systems. Traditional and design approach.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-3

Control systems: types of control system in mechatronics. Study on the control systems with examples: Room heating system and automated washing machine.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-4

Examples of mechatronics systems: study of digital camera and autofocus. Engine management system, Thermocouple, Automatic control of water level.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-5

Case studies of mechatronics systems: Washing machines, Digital photo copiers, Vending machines, Barcode reader, Hard disk drive.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Course outcome (Course Skill Set)

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

CO 1. Understand the functions of different mechatronics systems.

CO 2. Apply the knowledge of measurements and control systems in Mechatronics.

CO 3. Analyse the use of different types of mechatronics systems and its 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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

4. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005
5. Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA 2003.

Web links and Video Lectures (e-Resources):

- NPTEL courses on Mechatronics

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

- Quiz

ROBOTICS ECOSYSTEM			
Course Code	**21MT384**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50

Total Hours of Pedagogy	16	Total Marks	100
Credits	1	Exam Hours	1

Course Learning Objectives:

CLO 1. To introduce the functional elements of Robots

CLO 2. To educate on carious concepts in robot anatomy and control

CLO 3. To impart knowledge on end effectors and drive systems in robots

CLO 4. To know about different types and functions of sensors in robotics

CLO 5. To describe different applications of robots.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Show Video/animation films to explain the functioning of elements of Robotics
2. Encourage collaborative(Group)Learning in the class
3. Ask at least three HOTS (Higher-order Thinking)questions in the class, which promotes critical thinking
4. Adopt Problem Based Learning(PBL),which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

Module-1

Robotics Definition, Robot-Basic concepts, Need, Laws of Robotics, History, Types of Robots, Classification, specifications of Robotics.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-2

Anatomy of Robots, Types of Joints, Robot configurations- cartesian, cylinder, polar and articulate.
Basics of control: open loop- closed loop, Transfer functions, Control laws: P, PD, PID

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-3

End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system- Hydraulic, Pneumatic and Electrical Drive systems.

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-4

Sensors in robotics- Touch Sensors, Tactile sensor, Proximity and range sensors, Force sensor, Pressure sensors,

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Module-5

Applications: Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defence, Disaster management

Teaching-Learning Process	1. Chalk and talk method, 2. PowerPoint Presentation, 3. Videos

Course outcome (Course Skill Set)

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

CO 1. Understand the functions of different elements of robots.

CO 2. Apply the knowledge of sensors and end effectors in robotics

CO 3. Analyze the use of different types of robots for different 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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
2. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
3. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.

Web links and Video Lectures (e-Resources):

- NPTEL courses on Mechatronics

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

- Quiz, demonstration

For B.E COMPUTER SCIENCE AND ALLIED ENGINEERING BRANCHES
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)
(Effective from the academic year 2022-2023)
SEMESTER – IV

Mathematical Foundations for Computing, Probability & Statistics

Course Code	**21MATCS41**	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives:

This course(21MATCS41) will enable students to:

CLO 1. Understand an intense foundational introduction to fundamental concepts in discrete mathematics.

CLO 2. Interpret, identify, and solve the language associated with logical structure, sets, relations and functions, modular arithmetic.

CLO 3. To have insight into Statistical methods, Correlation and regression analysis. Fitting of curves.

CLO 4. To develop probability distribution of discrete and continuous random variables. Joint probability distribution occurs in digital signal processing, design engineering and microwave engineering.

Teaching-Learning Process (General Instructions):

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourse outcomes.

7. Inadditiontothetraditionallecturemethod,differenttypesofinnovativeteachingmethods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematicalskills.
8. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
9. Supportandguidethestudentsforself–study.
10. Youwillalsoberesponsibleforassigninghomework,gradingassignmentsandquizzes,and documenting students'progress.
11. Encouragethestudentsforgrouplearningtoimprovetheircreativeandanalyticalskills.
12. Showshortrelatedvideolecturesinthefollowingways:
    - Asanintroductiontonewtopics(pre-lectureactivity).
    - As a revision of topics (post-lectureactivity).
    - As additional examples (post-lectureactivity).
    - Asanadditionalmaterialofchallengingtopics(pre-andpost-lectureactivity).

    Asamodelsolutionforsomeexercises(post-lectureactivity).

Module – 1

8 HOURS

Fundamentals of Logic: Basic connectives and truth tables, Logical equivalence – The laws of Logic, Logical implication – Rules of Inference. Fundamentals of Logic contd.: The Use of Quantifiers, Quantifiers, Definitions, and the Proofs of Theorems. **(8 Hours)**

Self-study: Problems on Logical equivalence.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 2

8 HOURS

Relations and Functions: Cartesian Products and Relations, Functions – Plain and One-to-One, Onto Functions. Function Composition, and Inverse Functions.

Relations: Properties of Relations, Computer Recognition – Zero-One Matrices and Directed Graphs, Partial Orders – Hasse Diagrams, Equivalence Relations and Partitions.

Introduction to Graph Theory: Definitions and Examples, Subgraphs, Complements, and Graph Isomorphism, Vertex Degree, Euler Trails and Circuits.

Self-study: The Pigeon-hole Principle, problems and its applications

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 3

8 Hours

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation-problems. Regression analysis- lines of regression –problems.

Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form- $y = ax + b$, $y = ax^b$ and $y = ax^2 + bx + c$

Self-study: Angle between two regression lines, problems. Fitting of the curve $y = ab^x$

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 4

8 HOURS

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation, mean and variance. Binomial, Poisson and normal distributions- problems (derivations for mean and standard deviation for Binomial and Poisson distributions only)-Illustrative examples.

Self-study: exponential distribution.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 5

8 HOURS

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

Self-Study: Point estimation and interval estimation.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Course Outcomes

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

CO1. Apply the concepts of logic for effective computation and relating problems in the Engineering domain.

CO2. Analyse the concepts of functions and relations to various fields of Engineering. Comprehend the concepts of Graph Theory for various applications of Computational sciences.

CO3. Apply discrete and continuous probability distributions in analysing the probability models arising in the engineering field.

CO4. Make use of the correlation and regression analysis to fit a suitable mathematical model

for the statistical data.

CO5. Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

ASSESSMENT PATTERN (BOTH CIE AND SEE)

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Textbooks:

1. Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, Pearson Education, Asia, Fifth edition – 2007. ISBN 978-81-7758-424-0.
2. Higher Engineering Mathematics B. S. Grewal Khanna Publishers 44th Edition, 2017

References:

3. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata – McGraw Hill, Sixth Edition, Sixth reprint 2008. ISBN-(13):978-0-07-064824-1.
4. C. L. Liu and D P Mohapatra, Elementary Discrete Mathematics, Tata- McGraw Hill, Sixth Edition, ISBN:10:0-07-066913-9.
5. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata – McGraw Hill, 35TH reprint 2008. ISBN 13:978-0-07-463113-3.
6. Advanced Engineering Mathematics C. Ray Wylie, Louis C.Barrett McGraw-Hill 6th Edition 1995
7. Higher Engineering Mathematics B. V. Ramana McGraw-Hill 11th Edition,2010
8. A Text-Book of Engineering Mathematics N. P. Bali and Manish Goyal Laxmi Publications 2014

9. Advanced Engineering Mathematics Chandrika Prasad and Reena Garg Khanna Publishing, 2018

List of NPTEL videos for various topics of Discrete Mathematical Structures
https://www.youtube.com/watch?v=9AUCdsmBGmA&list=PL0862D1A947252D20&index=10
https://www.youtube.com/watch?v=oU60TuGHxe0&list=PL0862D1A947252D20&index=11
https://www.youtube.com/watch?v=_BIKq9Xo_5A&list=PL0862D1A947252D20&index=13
https://www.youtube.com/watch?v=RMLR2JHHeWo&list=PL0862D1A947252D20&index=14
https://www.youtube.com/watch?v=nf9e0_ylGdc&list=PL0862D1A947252D20&index=15
https://www.youtube.com/watch?v=7cTWea9YAJE&list=PL0862D1A947252D20&index=24
https://www.youtube.com/watch?v=695iAm935cY&list=PL0862D1A947252D20&index=25
https://www.youtube.com/watch?v=ZECJHfsf4Vs&list=PL0862D1A947252D20&index=26
https://www.youtube.com/watch?v=Dsi7x-A89Mw&list=PL0862D1A947252D20&index=28
https://www.youtube.com/watch?v=xlUFkMKSB3Y&list=PL0862D1A947252D20
https://www.youtube.com/watch?v=0uTE24o3q-o&list=PL0862D1A947252D20&index=2
https://www.youtube.com/watch?v=DmCltf8ypks&list=PL0862D1A947252D20&index=3
https://www.youtube.com/watch?v=jNeISigUCo0&list=PL0862D1A947252D20&index=4
http://nptel.ac.in/courses.php?disciplineID=111
http://www.class-central.com/subject/math(MOOCs)
http://academicearth.org/
VTU EDUSAT PROGRAMME – 20

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

- Quizzes
- Assignments
- Seminars

Electrical Drives and Controls (IPCC)			
Course Code	**21MT42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

Thecoursewillenablethestudentsto

CLO1.Acquireabasicunderstanding of electric drives.

CLO2.Understand the Drivemotorcharacteristics of both AC and DC Motors

CLO3.Apply different Startingmethods for AC and DC motor drives

CLO 4. Gain the knowledge of Conventionalandsolid-statespeedcontrolofD CDrives.

CLO 5.Know the concept of Conventionalandsolid-statespeedcontrolof A C Drives.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

7. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
8. ChalkandTalkmethodforProblemSolving.
9. ConductLaboratoryDemonstrationsandPracticalExperimentstoenhance
10. Experientialskills.

MODULE-1 **8 HOURS**

Introduction

Basic elements-types of electric drives-factors influencing electric drives-heating and cooling curves-loading conditions and classes of duty-Selection of power rating for drive motors with regard tothermaloverloadingandload variation factor

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration. 3. ChalkandTalkareusedforProblemSolving 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-2 **8 HOURS**

Drivemotorcharacteristics

Mechanical characteristics- speed- torque characteristics of various types of load and drive motors -braking of electrical motors-dc motors: shunt, series, compound motors-single phase and three phaseinduction motors

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk 3. LaboratoryDemonstrationsandPracticalExperiments.

MODULE-3 **8 HOURS**

Startingmethods

Types of DC motor starters-typical control circuits for shunt and series motors-three phase squirrel andslipringinduction motors

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk 3. LaboratoryDemonstrationsandPracticalExperiments.

MODULE-4 **8 HOURS**

ConventionalandsolidstatespeedcontrolofD.CDrives

Speed control of DC series and shunt motors-Armature and field control, ward-Leonard control system-usingcontrolled rectifiersandDCchoppers–applications

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk

	3. VideodemonstrationorSimulations, 4. LaboratoryDemonstrationsandPracticalExperiments
MODULE 5	**8 HOURS**
Conventionalandsolid-statespeedcontrolof ACdrives Speed control of three phase induction motor-Voltage control, voltage/frequency control, slip powerrecoveryscheme-usinginvertersandACvoltageregulators-applications	
Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalk 3. LaboratoryDemonstrationsandPracticalExperiments

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	conduct an experiment to control the speed of dc shunt motor by armature control method and to draw its speed characteristics.
2	Conduct an experiment to control the speed ofdcshuntmotorbyfieldcontrol method and draw its speed characteristics.
3	Conduct an experiment to Load testondcshunt motor and draw the speed, torquecharacteristics.
4	conduct an experiment to Load testondcshunt motor todraw the load v/sefficiencycharacteristics.
5	Conduct an experiment to control the speed of DC motors using ward-Leonard control system method
6	Conduct an experiment on Loadtestofsinglephaseinductionmotortodraw the outputversustorque,current,powerandefficiency characteristics.
7	Conduct an experiment on LoadtestofThreephaseinductionmotortodrawoutputversustorque,current,powerandefficiency characteristics
8	Conduct an experiment to control the speed of DC series motor and draw the speedcharacteristics.
9	Conduct an experiment to control the speed of DC compound motors and draw the speedcharacteristics.
10	Conduct an experiment to control the speed of Universal motor and draw the speedcharacteristics.
11	Conduct an experiment to control the speed of DC motors using chopper and draw the characteristics curve between duty cycle and speed.
12	Conduct an experiment to control the speed of three phase induction motor draw its characteristics
13	Conduct an experiment to understand the working of stepper motor

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:
CO 1. Understand the basic concept of Electric drives and controls.
CO 2. Explainthe characteristics of AC and DC Motor drives.
CO3. Apply conventional control methods for AC and DC drives.
CO 4. Apply solid-statespeedcontrol methods for AC and DC drives
CO 5. Conduct experiment to determine control characteristics of DC motors
CO 6. Conduct experiment to determine control characteristics of AC motors

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

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

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

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Vedamsubramaniam "Electric drives (concepts and applications)", Tata McGraw-Hill.2001
2. Nagrath.i.j&Kothari.D.P,"Electrical machines", Tata McGraw-Hill.1998

AdditionalReferences:

1. Pillai.s.k"Afirst courseonElectricdrives", WileyEastern Limited,1998
2. M.d.singh,K.b.khanchandani,"Powerelectronics,"TataMcGraw-Hill.1998
3. H.Partab,"Artandscienceandutilizationofelectricalenergy,"Dhanpat Raiandsons,1994

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

- Group activity
- Presentation
- Quiz

Hydraulics and Pneumatics (IPCC)			
Course Code	**21MT43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

CLO 1. To gain basic knowledge of hydraulic and pneumatic systems.
CLO 2. To Understanding the working principles of hydraulics and pneumatics components.
CLO 3. To Apply the knowledge of hydraulic systems to design hydraulic circuits for different application.
CLO 4. To Apply the knowledge of pneumatic systems to design pneumatic circuits for different application.
CLO 5. To Design hydraulic and pneumatic circuits with multicylinder applications using solenoid control.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.
3. ShowVideo/animationfilmstoexplainthefunctioningofvarioushydraulicand pneumaticcircuits.
4. Encouragecollaborative(Group)Learningintheclass.
5. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking.
6. AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills

such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

MODULE-1 **8 HOURS**

Introduction to Hydraulic and Pneumatic Systems: Definition of hydraulic system, structure of hydraulic control system. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic. advantages, limitations, applications

The source of hydraulic power: Pumps, classification of pumps, pumping theory of positive displacement pumps, construction and working of gear pumps, vane pumps, piston pumps, fixed and variable displacement pumps, pump performance characteristics, pump selection factor, problems on pumps

Teaching-Learning Process	1. Power-pointPresentation, 2. VideodemonstrationorSimulations, 3. ChalkandTalk. 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-2 **8 HOURS**

Hydraulic Actuators and Motors: Classification: cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Cylinder cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators.

Control Components in Hydraulic and Pneumatic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation

Teaching-Learning Process	PowerPointPresentation 1. VideodemonstrationorSimulations, 2. ChalkandTalk 3. LaboratoryDemonstrationsandPracticalExperiments

MODULE-3 **8 HOURS**

Hydraulic Circuit Design And Analysis: Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.

Maintenance of Hydraulic System: General type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid - particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting.

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. VideodemonstrationorSimulations, 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-4 **8 HOURS**

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols.

Pneumatic Control Valves:DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. VideodemonstrationorSimulations, 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE 5 **8 HOURS**

Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependent controls- types - construction - practical applications, Time dependent controls principle, Construction, practical applications.

Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.

Teaching-Learning Process	1. PowerPointPresentation, 2. ChalkandTalkareusedforProblemSolving. 3. VideodemonstrationorSimulations, 4. LaboratoryDemonstrationsandPracticalExperiments

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	To determine the performance of reciprocating hydraulic pump.
2	To determine the performance of Centrifugal hydraulic pump.
3	To control speed of single acting cylinder actuation on Hydraulic/Pneumatic Trainer
4	To control speed of double acting cylinder actuation on Hydraulic/Pneumatic Trainer
5	To develop sequencing circuit on Hydraulic/Pneumatic Trainer

6	To develop regenerative circuit on Hydraulic/Pneumatic Trainer
7	To design and develop synchronizing circuit on Hydraulic/Pneumatic Trainer
8	To design and analysis of Hydraulic Regenerative Circuit using Software (like SIMULINK)
9	To design and analysis of Hydraulic Synchronizing circuit using Software (like SIMULINK)
10	To design and analysis of pneumatic circuits using Software (like SIMULINK)
11	To Demonstrate the working of air compressor.
12	To demonstration of working of different types of valves.
13	To demonstration of working of solenoids.

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:
CO 1. Understand different components of pneumatic and hydraulic circuits.
CO 2. Demonstrate working of valves, solenoids, and pumps.
CO 3. Apply concepts of pneumatic and hydraulic to design and develop respective circuits.
CO 4. Design and analyse Hydraulic/pneumatic circuits.
CO 5. Design pneumatic circuits for various industrial applications using experimental pneumatic kits
CO 6. Create the graphical simulation for pneumatic and hydraulic circuits

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) 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 have ten questions. Each question is set for 20 marks.
2. 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.
3. 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 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. "Fluid Power with Applications", Anthony Esposito, Sixth edition, Pearson Education,Inc,2000. 'Pneumatics and Hydraulics', Andrew Parr, Jaico Publishing Co.
2. Fluid Mechanics and Fluid Machines, Dr. Bansal, R.K.Lakshmi Publications, 2004
3. 'Oil Hydraulic systems', Principles and Maintenance S. R. Majurr, Tata McGraw Hill PublishingCompany Ltd. – 2001
4. 'Industrial Hydraulics', Pippenger, Hicks" McGraw Hill, New York.
5. 'Hydraulic & Pneumatic Power for Production', HarryL. Stewart.
6. 'Pneumatic Systems', S. R. Majumdar, Tata McGraw Hill Publish 1995. 'Hydraulic & Pneumatics' CMTI Data Book.

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

1. To design and construct simple experiment to demonstrate Hydrostatic law
2. Demonstrationof Pascal's law with laboratory setup.
3. Industrial visit to understand the applications of hydraulic and Pneumatic systems.
4. Design anddemonstration of working of hydraulic/pneumatic systems for different day today application.

MICROCONTROLLER AND APPLICATIONS			
Course Code	**21MT44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: ToGain the knowledge of
CLO1. Microcontrollers, microprocessors, Different memory Architecture, interfacing techniques and 8051 architectures.
CLO2. Assembly language instructions, data types and application programming.
CLO3.C language instructions, data types and application programming, generating delays for different time delay.
CLO4. Serial communication between two devices using assembly and C language programming, Interrupt handling and counter application using assembly and C language .
CLO5. The controller to real-world devices such as switches, display devices, motors, converters etc.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
2. Encouragecollaborative(Group)Learningintheclass
3. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
4. Project based learning: AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

Module-1	**8 Hours**

Microprocessors and microcontroller
Introduction, Microprocessors and Microcontrollers, A Microprocessors survey. RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture. The 8051 Architecture: Introduction, 8051 Microcontroller Hardware, Input / Output Pins, Ports and Internal Memory organization. External Memory (ROM & RAM) interfacing

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation,

Module-2	**8 Hours**

Addressing Modes and Operations:
Introduction, addressing modes, External data Moves, Code Memory, Read Only Data Moves / Indexed Addressing mode, PUSH and POP Opcodes, Data exchanges, Byte level logical Operations, Bit level Logical Operations, Rotate and Swap Operations, Arithmetic Operations: Flags, Incrementing and Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Arithmetic.
Jump and Call Instructions: The JUMP and CALL Program range, Jumps, calls and Subroutines, Interrupts and Returns.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, simulation of programs

Module-3	**8 Hours**

8051 programming in C and Timers:
Data types and time delays in 8051C, I/O programming, logic operations, data conversion programs, data serialization.
Timer / Counter Programming in 8051: Programming 8051 Timers, modes of Timer

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, simulation of programs

Module-4	**8 Hours**

8051 Serial Communication and Interrupts: Basics of Serial Communication, 8051 connections to RS-232, 8051 Serial communication Programming, Programming the second serial port, Serial port programming in C. Interrupts Programming,8051 Interrupts, Programming Timer Interrupts, Interrupt Priority in the 8051/52.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, simulation of programs
Module-5	**8 Hours**
8051 Interfacing and Applications: Hardware & Software (Assembly code / C code) Interfacing of 8051 to simple switches and LEDs, LCD, ADC, Stepper motor, DC motor, Temperature sensor, Wave form generation	
Teaching-Learning Process	Chalk and talk method, hands on experiments

Course outcome (Course Skill Set)

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

CO1. Describe the architecture of 8051 Microcontroller, microprocessor and internal memory organization, types of memory architecture, Concept of Addressing modes and Assembly and C instruction set.

CO2. Apply various instruction set of assembly and C language for different software and hardware applications.

CO3. Calculate time delays, baud rates and analyze Timer. Counter operation and Transmission of data serially for different modes of operation.

CO4.Design the hardware interface between microcontroller and memories of different size , external peripheral devices for real time application.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

2. First test at the end of 5th week of the semester
3. Second test at the end of the 10th week of the semester
4. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

7. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

TextBooks:

Recommended Text Books

1. "The 8051 Microcontroller Architecture, Programming & Applications", 2e Kenneth J. Ayala ;, Penram International, 1996 / Thomson Learning 2005
2. "The 8051 Microcontroller and Embedded Systems – using assembly and C "-, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006

Reference Books:

1. "Programming and Customizing the 8051 Microcontroller" Predko ;–, TMH
2. Microcontrollers: Architecture, Programming, Interfacing and System Design",Raj Kamal, "Pearson Education, 2005
3. "Microcontrollers- Theory and Applications", Aja y V.Deshmukh; TMH,2005
4. "Microcontroller and its applications", Dr.RamaniKalpathi and Ganesh Raja; Sanguine Technical publishers, Bangalore-2005.

MECHATRONICS LABORATORY			
Course Code	**21MTL46**	CIE Marks	50
Teaching Hours/Week (L: T:P)	0:0:2	SEEMarks	50
Credits	01	Exam Hours	03

Course Learning objectives:

After studying thiscourse, students shouldbe able to

CLO1. study assembly language and C programming in 8051 for different applications

CLO 2. study interfacing of various peripherals using 8051

CLO 3. develop applications like generating waveforms, LCD display, stepper and DC motor control, temperature control etc. using 8051

CLO 4. calibrate the sensors like LVDT, load cell and Thermo couple

Sl. NO	**Experiments**
1	Conduct an experiment to calibrate LVDT
2	Conduct an experiment to calibrate Load cell
3	Conduct an experiment to calibrate Thermo couple
4	Write an ALP to execute the following Data Transfer operation – Block move, Exchange, Sorting, Largest and smallest element in an array.
5	Write an ALP to execute Arithmetic– Addition/subtraction, multiplication and division, square, cube – (16 bit number)
6	Write an ALP to perform following Code conversions: BCD – ASCII; ASCII – Decimal; Decimal – ASCII; HEX- Decimal and Decimal – HEX
7	Write an ALP to execute Logical Instructions –Byte and bit addressable operation
8	Write an ALP to generate delay, serial data transfer at different Baud rates.
9	Interface 8051 to DAC to Generate different waveforms Sine, Square, Triangular, Ramp, sawtooth, step wave.
10	Interface 8051 to Alphanumeric LCD, HEX keypad input to display the message" WELCOME"
11	Interface 8051 to Stepper motor and DC motor to rotate the motor at different step angle, clockwise and antilock wise direction.
12	Interface 8051 to DC motor to rotate the motor at different step angle, clockwise and antilock wise direction.
13	Interface 8051 to temperature control to measure and monitor the temperature.

Course outcomes:

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

CO1. Evaluate the performance of the sensors like LVDT, load cell and Thermo couple by Calibrating.

CO2.develop a various data transfer, arithmetic, logical and code conversion applications using Assembly Language.

CO3. Design a interface between 8051 and external peripherals for real time applications

AssessmentDetails(bothCIEandSEE)

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 40% of the maximum marks (20marks). A student shall be deemed to have satisfied the academic requirements and earnedthecreditsallottedtoeachcourse.Thestudenthastosecurenotlessthan35%(18Marksoutof 50) in the semester-end examination (SEE). A student has to secure overall 40% of themaximummarksofthecourse(CIE+SEE).

ContinuousInternalEvaluation(CIE):

CIEmarksforthepracticalcourseis**50Marks**.
Thesplit-upofCIEmarksforrecord/journalandtestareintheratio**60:40**.

- Eachexperimenttobeevaluatedforconductionwithobservationsheetandrecordwrite-

up.Rubricsfortheevaluationofthejournal/write-upforhardware/softwareexperimentsdesigned by the faculty who is handling the laboratory session and is made known tostudentsatthebeginningofthepracticalsession.

- Recordshouldcontainallthespecifiedexperimentsinthesyllabusandeachexperimentwrite-upwillbeevaluatedfor10marks.
- Totalmarksscoredbythestudentsarescaleddownedto30marks(60%ofmaximummarks).
- Weightagetobegivenforneatnessandsubmissionofrecord/write-upontime.
- Departmentshallconduct02testsfor100marks,thefirsttestshallbeconductedafterthe8thweek of the semester and the second test shall be conducted after the 14thweek of thesemester.
- Ineachtest,testwrite-up,conductionofexperiment,acceptableresult,andproceduralknowledgewillcarryaweightageof60%andtherest40%forviva-voce.
- Thesuitablerubricscanbedesignedtoevaluateeachstudent'sperformanceandlearningability.Rubricssuggestedin**Annexure-IIofRegulationbook**
- Theaverageof02testsisscaleddownto**20marks**(40%ofthemaximummarks).

TheSumofscaled-downmarksscoredinthereportwrite-up/journalandaveragemarksoftwotestsisthetotalCIEmarksscoredbythestudent.

SemesterEndEvaluation(SEE):

SEEmarksforthepracticalcourseis50Marks.

SEE shall be conducted jointly by the internal and external examiners appointed by theUniversity

Alllaboratoryexperimentsaretobeincludedforpracticalexamination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answerscript to be strictly adhered to by the examiners. **OR** based on the course requirementevaluationrubricsshallbedecidedjointlybyinternalandexternalexaminers.

Studentscanpickonequestion(experiment)fromthequestionslotpreparedbytheinternal /externalexaminersjointly.

Evaluationoftestwrite-up/conductionprocedureandresult/vivawillbeconductedjointlybyInternalandexternalexaminers.

GeneralrubricsforSEEarementionedhere,writeup-20%,Conductionprocedureandresultin - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100marks and scored marks shall be scaled down to 50 marks (however, based on course type,rubricsshallbedecidedbytheexaminers)

Changeofexperimentisallowedonlyonceand15%Marksallottedtotheprocedureparttobemadezero.

ThedurationofSEEis03hours

Rubricssuggestedin**Annexure-IIofRegulationbook**

Programming in Python			
Course Code	**21MT481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	2

Course Learning Objectives:

CLO 1. Demonstrate the use of Anaconda or PyCharm IDE to create Python Applications
CLO 2. Develop Python programming language to develop programs for solving real-world problems
CLO 3. Utilize Object-Oriented Programming concepts in Python.
CLO 4. Analyse the working of various documents like PDF, Word file

Sl.NO	Experiments
1	Develop a python program to find the best of two test average marks out of three test's marks accepted from the user.
2	Develop a python program to find the smallest and largest number in a list
3	Develop a python program to arrange the numbers in ascending and descending order
4	Develop a binary search program in python
5	Develop a bubble sort program in python
6	Develop a Python program to check whether a given number is palindrome or not and also count the number of occurrences of each digit in the input number.
7	Write a Python program that accepts a sentence and find the number of words, digits, uppercase letters and lowercase letters.
8	Write a Python program for pattern recognition with and without using regular expressions
	Demonstration Experiments (For CIE)
9	Demonstrate python program to read the data from the spreadsheet and write the data in to the spreadsheet
10	Demonstration of reading, writing and organizing files.
11	Demonstration of the concepts of classes, methods, objects and inheritance
12	Demonstration of working with PDF and word files

Course outcomes (Course Skill Set):

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

CO 1. Demonstrate proficiency in handling of loops, lists and creation of functions.
CO 2. Identify the commonly used operations involving regular expressions and file system.
CO 3. Examine working of PDF and word file formats

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3" 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Download pdf files from the above links)
3. Al Sweigart, "Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)
4. ReemaThareja "Python Programming Using Problem Solving Approach" Oxford University Press.

3D-Printing Technology			
Course Code	**21MT482**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	2

Course Learning Objectives:

CLO 1. Familiarize students with 3D printing technology
CLO 2. Develop the ability to assess printing methods and materials for specific applications
CLO 3. Develop ability to design and 3D print complex devices/tools
CLO 4. Design and development of 3D printer

Sl.NO	Experiments
1	Demonstration of different 3D Printer components
2	Hands on CAD and slicing software
3	Selection of Elements and Materials used in simple 3D printer.
4	Integration of 3D printers with open-source software
5	Hands on training on CAD / Design software (Project I)- Rectangular model
6	Developing the program for 3D printer for Project I using open-source software
7	Hands on training on CAD / Design software (Project II)- circular model
8	Developing the program for 3D printer for Project II using open-source software
	Demonstration Experiments (For CIE)
9	Troubleshooting
10	Integration of 3D printing software with hardware
11	Produce different shapes of products through the Developed 3D printer
12	3D printer Troubleshooting

Course outcomes (Course Skill Set):

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

CO 1. Understand steps, software and different key elements used in 3D printer.
CO 2. Develop a program using open-source software to use 3D printer
CO 3. Apply the knowledge of 3D printers in building model.

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Additive Manufacturing Technologies – 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, by Ian Gibson, David Rosen, and Brent Stucker, Second Edition, Springer, New York.
2. Fabricated: The New World of 3D Printing by Hod Lipson and Melba Kurman
3. Design and Modeling for 3D Printing by Matthew Griffin
4. AutoDesk 123D Gallery: http://www.123dapp.com/Gallery/content/all
5. SketchUp Gallery: https://3dwarehouse.sketchup.com/
6. SolidWorks Gallery: http://www.3dcontentcentral.com/default.aspx

CNC Programming and Simulation			
Course Code	**21MT483**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	2

Course Learning Objectives:

CLO 1. Understand CNC lathe and CNC Milling machines
CLO 2. Know the functions of different G codes and M codes
CLO 3. Simulate different machining operations using simulation software
CLO 4. Develop a part program for different machining operations

Sl.NO	Experiments
1	Write simple CNC Programs using G Codes and M Codes
2	Develop a CNC program and simulate simple plain turning using software (like NX CAM)
3	Develop a CNC program and simulate step turning using software (like NX CAM)
4	Develop a CNC program and simulate step turning using software (like NX CAM)
5	Develop a CNC program and simulate tread cutting operation using software (like NX CAM)
6	Create CNC programming Simulation for plain milling operation using software (like NX CAM)
7	Develop a part program for circular interpolation and simulate
8	Develop a part program for rectangular and circular pocketing and simulate
	Demonstration Experiments (For CIE)
9	Develop a part program for drilling (canned cycle) and simulate
10	Develop a part program for mirroring with subroutines and simulate
11	Develop a part program for internal drills, boring and simulate
12	Develop a part program for a CNC machine and observe the CNC machining operation physically

Course outcomes (Course Skill Set):

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

CO 1. Understand the codes (G-code and M-Code) used in CNC machines for programming
CO 2. Develop Programming skill to write program for different machining operations.
CO 3. Simulate different machining operations using simulation software tools.

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- CAD/CAM: computer aided design and manufacturing, GrooverMikell P, Zimmered W Emory, Prentice Hall 2014

IoT			
Course Code	**21MT484**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	2

Course Learning Objectives:

CLO 1. Demonstrate to install IDE to create IoT application
CLO 2. Illustrate diverse methods of deploying smart objects and connect them to network.
CLO 3. Develop Python programming language to develop programs for solving real-world problems
CLO 4. Analyse sensor technologies for sensing real world entities

Sl.NO	Experiments
1	Design a smart bin using IoT with Arduino / Raspberry Pi
2	Design water level monitoring system using IoT with Arduino / Raspberry Pi
3	Design temperature monitoring system using IoT with Arduino / Raspberry Pi
4	Design car parking management system using IoT with Arduino / Raspberry Pi
5	Design automated pet feeder using IoT with Arduino / Raspberry Pi
6	Design smart agriculture system using IoT with Arduino / Raspberry Pi
7	Design smart street light monitoring system using IoT with Arduino / Raspberry Pi
8	Design smart anti-theft system using IoT with Arduino / Raspberry Pi
	Demonstration Experiments (For CIE)
9	Demonstrate Alexa based smart home monitoring system using IoT
10	Demonstration ECG monitoring using IoT
11	Demonstration home automation system using IoT
12	Demonstration of face recognition bot using IoT

Course outcomes (Course Skill Set):

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

CO 1. Understand basic concepts of IoT, Arduino / Raspberry Pi
CO 2. Build application-oriented projects using IoT
CO 3. Develop algorithm to solve real time problems by interface sensors and controller

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Books:

1. 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)
2. Srinivasa K G, "Internet of Things",CENGAGE Leaning India, 2017

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 stEdition, VPT, 2014.

(ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1 st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

Course Code	**21MT51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

CLO 1. TogainknowledgeofKinematicsassociatedwithmachines and inversions of machines.
CLO 2. Tocalculatepowerlossin belt drives and toConstructdifferentcamprofiles.
CLO 3. To design a machine, elements against static loads.
CLO 4. To design a machine element under Fluctuate in loads considering stress concentration factor.
CLO 5. To design spur and helical gears for dynamic and wear loads.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

5. Power Point Presentation,
6. Chalk and Talk are used for Derivations and Correlations (In-general).
7. Video demonstration or Simulations,

Module-1 **8 HOURS**

Introduction to machine theory: Mechanisms: Definitions: Link, types of links, joint, types of joints kinematic pairs, Constrained motion, kinematic chain, mechanism and types, degrees of freedom of planar mechanisms, Equivalent mechanisms, Groshoff's criteria and types of four bar mechanisms, inversions of four bar chain, slider crank chain, Doubler slider crank chain and its inversions, Grashoff's chain. Mechanisms: Quick return motion mechanisms Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-2 **8 HOURS**

Belt Drivers: Belt Drives: FlatBeltDrives,RatioofBeltTensions,CentrifugalTension,power Transmittedandsimplenumerical.

Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curve forcam profiles. Disccam withreciprocating followerhavingknife-edge,rollerfollower, FollowermotionsincludingSHM,Uniformaccelerationandretardationand Cycloidalmotion.

Teaching-Learning Process	1. . PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-3 **8 HOURS**

Design against static load: Machine design, classification of machine design, design consideration, Tri axial stresses, Stress Tensor. Codes and Standards. Factor of Safety, design procedure for simple and combined stresses (No Numerical). Modes of failures. Concurrent engineering. Design synthesis.

Introduction to Theories of failure: Maximum Normal Stress Theory, Maximum Shear Stress Theory, Distortion Energy Theory.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).

	4. Laboratory Demonstrations and Practical Experiments
Module-4	**8 HOURS**
Design against fluctuating loads. Introduction to Stress Concentration, Stress concentration Factor and its effects (Simple problems). **Fatigue Loads:** Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments
Module-5	**8 HOURS**
Design of Spur Gears: Beam strength of spur gear, Stresses in gear teeth (Lewis's equation), dynamic tooth load, design for wear **Design of helical gears:**Beam strength of helical gear, Stresses in gear teeth (Lewis's equation), dynamic tooth load, and design for wear.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Course outcome (Course Skill Set)

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

CO 1. IllustrateKinematicsofMachines, theories of failures and stress concentration

CO 2. Determine the mobility, power loss due in belt drives.

CO 3. Calculate the stresses, parameters of machine elements subjected to various loads also make proper assumptions with respect to material, FOS for various machine components.

CO 4. Design machine elements like, gears and other simple machine elements.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. TheoryofMachines:SadhuSingh,PearsonEducation,2ndedition,2007.
2. TheoryofMachines:RattanS.STataMcGrawHillPublishingCompanyLtd.,NewDelhi,2ndEdition,2006.
3. TheoryofMachines,R.S.Khurmi,J.K.Gupta,EurasiaPublishingHouse,2008RevisedEdition.
4. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6thEdition 2009.
5. Design of Machine Elements, V.B. Bhandari, Tata Mc GrawHill Publishing Company Ltd., New Delhi, 3rd Edition 2010. 3.
6. Machine Design, by Dr. P C Sharma and Dr. D K Aggarwal, S. K. Kataria& Sons, 11th Edition 2009

DESIGN DATA HANDBOOK:

1. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication.
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2ndEdition.
3. Design Data Hand Book, H.G. Patil, I. K. International Publisher, 2010.

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

- Quiz
- Presentation
- Group Activity

MICRO AND SMART SYSTEM TECHNOLOGY			
Course Code	**21MT52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course Learning Objectives:

CLO 1. Understand the operation and Importance of Micro and Smart Systems.

CLO 2. Understand the Working Principle and Operation of Various Kinds of Sensors and Actuators.

CLO 3. Understand the Fabrication Process of Micromachining.

CLO 4. Understand the operation of Electronics Circuits for Micro and Smart Systems.

CLO 5. Understand the Working Principle of Controllers for MEMS and BEL Pressure Sensor and Smart Structure in vibration control.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Power Point Presentation,
2. Chalk and Talk are used for Derivations and Correlations (In-general).
3. Video demonstration or Simulations,
4. Laboratory Demonstrations and Practical Experiments

MODULE-1

8 HOURS

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations, 4. Laboratory Demonstrations and Practical Experiments

MODULE-2

8 HOURS

Micro and Smart Devices and Systems: Principles and Materials:Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, Piezoresistive pressure sensor, Portable blood analyzer, Conductometric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations, 4. Laboratory Demonstrations and Practical Experiments

MODULE-3

8 HOURS

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachining bulk micromachining. Specialized Materials for Microsystems.

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations, 4. Laboratory Demonstrations and Practical Experiments.

MODULE-4

8 HOURS

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode, Tunnel diode, Bipolar Junction Transistor (BJT), MOSFET, and CMOS circuits: Inverter and NAND Gate, Electronics Amplifiers: Operational Amplifiers, Basic Op-Amp circuit, Op-Amp based circuits.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations, 4. Laboratory Demonstrations and Practical Experiments.

MODULE 5

8 HOURS

Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems. Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations, 4. Laboratory Demonstrations and Practical Experiments.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Simulate for Maximum Stress and Displacement for a given structural member taking modulus of elasticity 200GPa ,Poisson's Ratio 0.25 and Thickness of plate 10mm on ANSYS tool.
2	Simulate for Maximum Stress and Displacement for a given structural Bracket taking modulus of elasticity 190GPa, Poisson's Ratio 0.30 and Thickness of a bracket 10mm subjected to a load of 10KN ,Pressure of 0.8MPa for the given region on ANSYS tool.
3	Simulate for Maximum Stress and Displacement for the given 3-D L bracket by taking modulus of elasticity of material 190GPa ,thickness of the plate is 20mm and μ=0.29 on ANSYS tool.
4	Perform static analysis for an applied beam tip deflection of 10mm and determine the electrode voltage for the piezoelectric beam on ANSYS tool.
5	Perform static analysis for an applied voltage of 100V and determine the beam tip deflection for the piezoelectric beam on ANSYS tool.
6	Model the given object as a 3D entity of thickness 5mm and determine maximum electrode voltage for the piezoelectric of deflection of 25mm on ANSYS tool.
7	Perform static analysis for an applied voltage of 50V and determine the beam tip deflection for the piezoelectric beam on ANSYS tool.
8	Perform static analysis for an applied beam tip deflection of 15mm and determine the electrode voltage for the piezoelectric beam on ANSYS tool.
9	Rig up a Circuit to find the characteristics of a Typical 10 Bar Compensated Pressure Sensor to determine Offset Voltage, Sensitivity and Non Linearity.
10	Rig up a Circuit to find the characteristics of a typical 5 Bar BEL Pressure Sensor to determine Sensitivity and Non Linearity.
11	Rig up a Circuit to find the characteristics of a typical 10 Bar BEL Pressure Sensor to determine Sensitivity and Non Linearity.
12	Rig up a Circuit to find the characteristics of a typical 20 Bar BEL Pressure Sensor to determine Sensitivity and Non Linearity.
13	Rig up a Circuit to find the characteristics of a Compensated Pressure Sensor to determine Offset Voltage, Sensitivity and Non Linearity.

Course outcomes (Course Skill Set):

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

- **CO1.** Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.
- **CO2.** Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.
- **CO3.** Examine the behavior of piezoresistive& piezoelectric materials required to fabricate pressure sensor & vibration control structures.
- **CO4.** Measure the performance of pressure sensor & vibration control structure in real time applications.
- **CO5.** Analyze the behavior of smart materials for different parameters to has sensor and an actuator.
- **CO6.** Determine the sensitivity, non linearity and offset voltage of raw pressure sensors and compensated pressure sensor.

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) 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 have ten questions. Each question is set for 20 marks.
2. 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.
3. 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 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
3. MEMS- NitaigourPremchandMahalik, TMH 2007.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

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

1. Students are segregated in groups of 5members made to Prepare models of FCC structure of Silicon and Patterns to demonstrate the process of Photolithography.
2. Students are segregated in groups of 5members made to Prepare models of Cantilever Beam to analyze the vibration control and Patterns to demonstrate the process of Etching.
3. Quiz

INDUSTRIAL AUTOMATION			
Course Code	**21MT53**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning Objectives:

CLO1. Acquire the basic understanding of automation in production system

CLO2. Acquireabasicunderstandingofmaterial handling and identification technologies

CLO3. Understanding of Automated Manufacturing systems

CLO4. Acquireabasicunderstandingof computer based industrial automation

CLO5.Acquireabasicunderstandingof Distributed Control Systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.
3. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
4. Adoptcollaborative(GroupLearning)Learningintheclass.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1 **8 HOURS**

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process

Teaching-Learning Process	5. Power-pointPresentation, 6. Videodemonstration 7. ChalkandTalkareusedforProblemSolving (In-general)

Module-2 **8 HOURS**

Material handling and identification technologies: Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, Overview of Automatic Identification Methods.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-3 **8 HOURS**

Automated Manufacturing Systems: Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-4 **8 HOURS**

Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation	
Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).
Module-5	**8 HOURS**
Distributed Control System: Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS. Introduction to communication protocols- Profibus, Field bus, HART protocols. Data gathering, Data analytics, Real-time analysis of data stream from DCS, Historian build, Integration of business inputs with process data, Leveraging RTU (as different from PLCs and DCS)	
Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

At the end of the course the student will be able to:
CO 1. Understand the need and basics of Industrial Automation,
CO 2. Understand knowledge on Automated Manufacturing system
CO 3. Analyze different types of automated manufacturing systems
CO 4. Design material handling system in Manufacturing system

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

8. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

4. M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th Edition, Pearson Education, 2009
5. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
6. Lukas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.

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

- Industrial visit to any automated production system
- Practical examples of automation used in Industries
- Group discussion on possibility of converting conventional manufacturing system to automated manufacturing system with advantages and Limitations

CONTROL THEORY AND VIRTUAL INSTRUMENTATION			
Course Code	**21MT54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

CLO 1. Gain fundamental knowledge of control systems, mathematical modelling of physical system
CLO 2. Solve the control system problems using block diagram reduction technique and Mason's gain formula
CLO 3. Understand the importance of Virtual Instrumentation and various operation of DAQ devices
CLO 4. Identify and analyse the basic programming concepts in Lab View
CLO 5. Compare types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol, and examine analysis tools

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

11. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
12. Chalk and Talk method for Problem Solving.
13. Arrange visits to show the live working models other than laboratory topics.
14. Adopt collaborative (Group Learning) Learning in the class.
15. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
16. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

8 HOURS

MODELLING OF SYSTEMS AND BLOCK DIAGRAM:

Introduction to control systems, types of control systems, with examples. concept of mathematical modelling of physical systems- mechanical, translational (mechanical accelerometer, systems excluded), and rotational systems, analogous systems based on force voltage analogy and force current analogy.

Teaching-Learning Process	5. PowerPointPresentation 6. Videodemonstration 7. ChalkandTalk 8. LaboratoryDemonstrationsandPracticalExperiments

Module-2

8 HOURS

BLOCK DIAGRAM:

Introduction to block diagram algebra and numerical problems

SIGNAL FLOW GRAPH: Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula.

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Module-3

8 HOURS

CONCEPT OF VIRTUAL INSTRUMENTATION AND DAQ SYSTEMS:

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.

PC based data acquisition, Signal conditioning functions, calibration, resolution, ADC, DAC, Single-ended and differential inputs, Sampling fundamentals – sampling, sampling theorem, sampling frequency

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Module-4 **8 HOURS**

CONCEPTS OF GRAPHICAL PROGRAMMING:
Lab-view software – Concept of VIs and sub VI, Loops (While Loop and For Loop), Structures (Case, Formula node, and sequence structures) Arrays Operations, Strings Operations, and file I/O. Examples on each.

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Module-5 **8 HOURS**

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.

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Course outcome (Course Skill Set)

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

CO1. Demonstrate the concepts of control systems and its specifications for mathematical modelling

CO2. Understand the structured LabVIEW programming concepts in developing Virtual Instrumentation and use general purpose interface bus and Serial communication Interface.

CO3. Develop the mathematical model for mechanical and electrical systems.

CO4. Analyse various applications on Real time monitoring using DAQ boards

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

9. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

TEXT BOOKS:

1. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
2. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003
3. "Control Systems Engineering", I.J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.
4. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.

REFERENCE BOOKS

1. PC Interfacing for Data Acquisition and Process Control &S.Gupta and JP Gupta InstrumentSocietyofAmerica,1994
2. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
3. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
4. "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

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

- Group activity
- Quiz
- Presentation

VIRTUAL INSTRUMENTATION LAB			
Course Code	**21MTL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	1	Exam Hours	3

Course Learning Objectives:

CLO 1. Understand the fundamental concepts of Scientific Programming using Lab View

CLO 2. Build VI using LabViewfor solving real-world problems

CLO 3. Develop proficiency in handling loops and structures

CLO 4. Design applications that uses plug in DAQ boards and built-in analysis functions to process the data

Sl.NO	Experiments
1	Creating Virtual Instrumentation for simple applications- invert the state of Boolean indicator twice until program is stopped by user
2	Create a Virtual Instrumentation for continuous monitoring of Temperature (Generated using Random no 0<t<100). for every 250ms
3	Design a simple calculator using case structure in virtual instrumentation
4	Design a VI for flat sequence and formula node
5	Design 1D array and reverse 1D array obtained by random numbers
6	Design On – Off Controller Using Switch Button
7	Develop an Analog Signal using Potentiometer and DAQ card
8	Developing voltmeter using DAQ cards
	Demonstration Experiments (For CIE)
9	Develop a VI for file input output system.
10	Develop a VI to display random number into 3 different CHARTS (STRIP, SLOPE, and SWEEP)
11	Design a Controller using Proximity Switch for ON-OFF Controller
12	Design an Audio I/O system using DAQ card

Course outcomes (Course Skill Set):

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

CO1. Develop LabVIEW programming which employs simulating and analysing the data for real time automation

CO2. Create different control applications using tools available in LabVIEW.

CO3. Design applications that use plug in DAQ boards and built-in analysis functions to process the data.

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
2. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003

MATLAB for Mechatronics			
Course Code	**21MT581**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	100

Course objectives:

CLO 1. To obtain the Transfer Function and State Space Modelling and simulation of Physical systems

CLO 2. To study the time response of first and second order system

CLO 3 .To study the error analysis of different control system

CLO4. To study the compensation techniques used to stabilize the system

Sl.No	Experiments
1	Mathematical (Transfer Function) modelling and simulation of any Mechanical System and any Electrical System using Matlab® (Simulink) / Scilab (xcos) or similar software.
2	Mathematical (State Space) modelling and simulation of any Mechanical System and any Electrical System using Matlab / Scilab or similar software.
3	Mathematical (Transfer Function) modelling of DC Motor using Matlab (Simulink) / Scilab or similar software.
4	D.C. Motor Parameter Identification.
5	Experiment on components of control system.
6	Transient response of 1st order & 2nd order system.
7	Frequency response of 1st order & 2nd order system.
8	Time and Frequency Response simulation in Matlab/Scilab.
	Demonstration Experiments
9	Steady state error analysis of different types of systems.
10	Stability analysis of a given Transfer Function based on Bode plot / Root locus / Nyquist plots usingMatlab.
11	Design of Proportional Controller of Velocity for a DC Motor in Matlab/Scilab.
12	Frequency Response based Design of PD Position Control of a DC Motor in Matlab/Scilab.

Course outcomes (Course Skill Set):

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

- **CO1.** Model and simulate physical systems using software tools
- **CO2.** Perform Parameter Identification
- **CO3.** Define the open loop and closed loop system
- **CO4.** Simulate time and frequency response of first and second order systems.
- **CO5.** Simulate the control system for getting different responses.
- **CO6.** Design the controller for position/velocity control of DC Motor

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination (SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Vijay Madisetti, ArshdeepBahga, Internet of Things. "A Hands on Approach", University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

EMBEDDED SYSTEMS			
Course Code	**21MT582**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	02

Course Learning Objectives:

CLO 1. Understand the instruction set of ARM Cortex M3, a 32-bit microcontroller, and the software tool required for programming in Assembly and C language.

CLO 2. Program ARM Cortex M3 using the various instructions in assembly level language for different applications.

CLO 3. Interface external devices and I/O with ARM Cortex M3.

CLO 4. Develop C language programs and library functions for embedded system applications.

Sl.NO	Experiments
1	Write an ALP (Assembly Language Program) to multiply two 16-bit binary numbers
2	Write an ALP to find the sum of first 10 integer numbers.
3	Write an ALP to find determine whether the given 16 bit is even or odd
4	Develop an Interface a DAC and generate Triangular and Square waveforms.
5	Write and execute a program to display the “Hello world” message using internal UART
6	Develop an Interface and control the speed of a DC Motor.
7	Develop and Interface a Stepper motor and rotate it in the clockwise and anti-clockwise direction
8	Develop a program to use of an external interrupt to toggle an LED On/ Off
	Demonstration Experiments (For CIE)
9	Interface a 4x4 keyboard and display the key code on an LCD.
10	Interface a simple Switch and display its status through Relay, Buzzer, and LED
11	Display the Hex digits 0 to F on a 7 -segment LED interface, with an appropriate delay
12	Measure Ambient temperature using a sensor and SP1 ADC IC

Course outcomes (Course Skill Set):

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

CO1. Understand the instruction set of 32-bit microcontroller ARM Cortex M3, and the software tool required for programming in Assembly and C language.

CO2. Develop assembly language programs using ARM Cortex M3 for different applications.Interface external devices and 1/0 with ARM Cortex M3.

CO3. Develop C language programs and library functions for embedded system 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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of the Regulation book

Suggested Learning Resources:

1)ARM Assembly Language: Fundamentals and Techniques by William Hohl.

2)Getting Started with MDK by ARMKEIL.

3)LPC1768 User Manual.

4)The Designer's Guide to the Cortex-M Processor Family :A Tutorial Approach by Trevor Martin.

FINITE ELEMENT MODELLING AND ANALYSIS			
Course Code	**21MT583**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course Learning Objectives:

CLO1. To acquire basic understanding of Modeling and Analysis software
CLO2. To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations.
CLO3. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.
CLO4. To understand Piezoelectric analysis of cantilever beam.

Sl.NO	Experiments
1	Demonstrate FEA package and modeling the different structural elements.
2	Modeling and stress analysis of a rectangular plate with a circular hole.
3	Modeling and stress analysis of "L" Bracket for pressure load.
4	Modeling and stress analysis of Bars of constant cross section area.
5	Modeling and stress analysis of Bars of tapered cross section area.
6	Modeling and stress analysis of stepped bar.
7	Stress analysis of Beams – Simply supported, cantilever, beams with point load.
8	Stress analysis Trusses.
	Demonstration Experiments (For CIE)
9	Dynamic Analysis to find natural frequency of beam with fixed – fixed end condition
10	Dynamic Analysis to find response of beam with fixed – fixed end conditions subjected to forcing function.
11	Demonstrate at least two different types of examples to model and analyze bars or plates made from composite material.
12	Piezoelectric analysis: cantilever beam.

Course outcomes (Course Skill Set): At the end of the course the student will be able to:
CO1. Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.
CO2. Demonstrate the ability to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.
CO3. Carry out dynamic analysis and finding natural frequencies of beams, for various boundary conditions and also carry out dynamic analysis with forcing functions.

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination(SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 02 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

REFERENCE BOOKS:

1.ANSYS Workbench Tutorial Release 14, Structural and Thermal Analysis Using Ansys Mechanical APDL Release 14 Environment, Kent Lawrence, Schroff Development Corporation, Website: www.SDCpublications.com

2.Practical Finite Element Analysis,Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite, Finite To Infinite, ISBN 978-81-906195-0-9, E-mail: finite@vsnl.com, Website: www.finitetoinfinite.com 3. FINITE ELEMENT ANALYSIS USING ANSYS®, SrinivasPaleti, Sambana, Krishna Chaitanya, Datti, Rajesh Kumar, PHI Publication, ISBN: 978-81-203-4108-1

WEB REFERENCE:

1. www.ansys.com
2.www.mece.ualberta.ca/tutorials/ansys
3. http://mae.uta.edu/~lawrence/
4. http://expertfea.com/tutorials.html

AI and ML			
Course Code	**21MT584**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	100

Course objectives:

CLO 1. To realize the basic techniques to build intelligent systems

CLO 2.To apply appropriate search techniques used in problem solving

CLO 3. To create knowledge base for uncertain data

CLO 4. Compare and contrast the learning techniques like ANN approach, Bayesian learning and reinforcement learning.

CLO 5. To impart the knowledge of clustering and classification Algorithms for predictions and evaluating Hypothesis.

Sl.No	**Experiments (Programming in Python)**
Prerequisite: Installation of Python and setting up a programming environment such as Anaconda and Spyder, Jupyter notebook, etc.	
	Artificial Intelligence Experiments
1	Write a Program on uninformed search methods.
2	Write a Program on informed search methods.
3	Write a Program on Game playing algorithms.
4	Write a Program for first-order Logic
5	Write a Planning Programming
6	Write a program to Implement Bayes Belief Network
	Machine Learning Experiments
7	Illustrate and demonstrate the working model and principle of the Find-S algorithm
8	To construct the Decision tree using the training data sets under supervised learning concept.
	Demonstration Experiments
9	To understand the working principle of Artificial Neural network with feed forward and feed backward principle.
10	Implement and demonstrate the working model of K-means clustering algorithm with Expectation Maximization Concept.
11	Understand and analyse the concept of Regression algorithm techniques.
12	Implement and demonstrate classification algorithm using Support vector machine Algorithm.

Course outcomes (Course Skill Set):

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

CO1. Understand and implement uninformed and informed searching techniques for real world problems.

CO 2.Create a knowledge base using any AI language.

CO 3.Design and implement expert systems for real world problems.

CO 4.Understand the Importance of different classification and clustering algorithms.

CO 5. Demonstrate the working of various algorithms with respect to training and test data sets.

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 40% of the maximum marks (20 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 35% (18 Marks out of 50) in the semester-end examination (SEE).

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. Rubrics suggested in Annexure-II of Regulation book
- 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 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Stuart J Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.
2. Tom M Mitchell, "Machine Lerning",1st Edition, McGraw Hill Education, 2017.
3. NelloCristianini, John Shawe Taylor, An Introduction to Support Vector Machines and Other Kernel-based Learning Methods, Cambridge University Press, 2013
4. Allen B Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at
5. http://greenteapress.com/thinkpython2/thinkpython2.pdf)

Suggested Web Links / E Resource

1. https://www.kaggle.com/general/95287
2. https://web.stanford.edu/~hastie/Papers/ESLII.pdf

CONDITION MONITORING AND MAINTENANCE MANAGEMENT			
Course Code	**21MT61**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

Course Learning objectives: ToGain the knowledge of

CLO1. Preventive and predictive maintenance.

CLO2. Application of computers in maintenance, financial aspects of maintenance, reliability and probability concepts.

CLO3. To learn about reliability cantered maintenance concepts.

CLO4. Application of total productive maintenance.

CLO5. Condition monitoring of components.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
2. Encouragecollaborative(Group)Learningintheclass
3. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
4. Project based learning: AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

Module-1

8 HOURS

Maintenance systems: Maintenance objectives and scopes; Maintenance strategies & organizations; Maintenance works; life cycle costs Preventive Maintenance (PM): Principles of preventive maintenance, procedures & selection; Preventive Maintenance planning, scheduling and control; Forms & resources; Maintenance work measurement; Modeling and analysis techniques in PM and inspections; Predictive maintenance.

Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos, Videos on the concepts.

Module-2

8 HOURS

Computerized Maintenance Management systems: Benefits and applications; Work order systems & plant registers; Maintenance reports, analysis and monitoring; Introduction to commercial packages Equipment maintenance: Installation, commissioning and testing of plant equipment, checking for alignment, lubrication and lubrication schedule; maintenance of typical rotating and process equipment systems like turbines, pumps, heat exchangers, boilers and pressure vessels etc.

Reliability & probability Concepts: Basic concepts of probability theory and distributions, definition of reliability, failure probability, reliability and hazard rate function, MTBF and MTTR, System reliability, series and parallel system, redundancy.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation.

Module-3

8 HOURS

Reliability Centered Maintenance: principles of RCM, Benefits of RCM, application of RCM Step-by-step procedure in conducting RCM analysis. The Plant Register. Functions and Failures. Failure mode and effect analysis (FMEA). Failure consequences. Maintenance and decision making. The RCM

Decision diagram. The nature of Failure and Technical history.	
Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos.

Module-4

8 HOURS

Total Productive Maintenance (TPM): Goals of TPM and methodology, TPM improvement plan & procedures. The modern role of care and asset management through TPM The use of TPM concepts consisting of Pareto ABC analysis, Fishbone diagrams, and 5S.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation.

Module-5

8 HOURS

Condition Monitoring:
Measurable phenomena from different Plant Items:
Measurable phenomena associated with degradation from a range of plant items including motors/generators, connectors and circuit breakers.
Fault diagnosis of Rotational Machines:
Unbalance, shaft and coupling misalignments, bent shafts, gear and bearing wear, oil whirls and shaft eccentricity.
Measurement Strategies and Techniques:
A wide range of strategies and associated technologies will be discussed including light emission (photo multipliers, fiber optic techniques etc.), heat emissions (IR, cameras, direct temperature measurement, etc.).
Data Processing and Analysis:
For each of the approaches, options with respect to data processing and analysis will be discussed including digital signal processing and computational techniques.

Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos.

Course outcomes (Course Skill Set)
At the end of the course the student will be able to:

CO1: Obtain knowledge of reliability, maintenance of system, productive maintenance, fault detection an diagnosis.

CO2: Explain failure, failure frequency, maintenance, concepts of reliability and probability, and reliabilit centered maintenance.

CO3: Apply the techniques of total productive maintenance and reliability centered maintenance.

CO4: Measure and analyze condition of the components to monitor the faults.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

TEXT BOOKS:

1. Practical machinery Vibration Analysis & Predictive Maintenance, C. Scheffer and P. Girdhar,, IDC technologies, 2004.
2. Introduction to Machinery Analysis and Monitoring, John S. Mitchell, PennWell Books, 1993.
3. Machinery Vibration, Measurement and Analysis, Victor Wowk, Mc Craw Hill,1991

REFERENCE BOOKS:

1. Handbook of Condition Monitoring, B.K.N. Rao,1996
2. Reliability Engineering, Srinath L S,
3. Maintenance Replacement and Reliability, Jardine AKS,
4. Practical reliability engineering, Oconnor, Patrick D T
5. Reliability and Maintainability Engineering, Charles E Ebeling
6. Introduction to Reliability Engineering Lewis E,

PROGRAMMABLE LOGIC CONTROLLER AND SCADA TECHNOLOGY			
Course Code	**21MT62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

CLO 1. Understand the basics and different types of PLC
CLO 2. Solve various logical operations using relay logic and construct equivalent ladder diagram
CLO 3. Analyse the working of counters, timers and comparators
CLO 4. Diagnosis the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.
CLO 5. Understand basic concepts of SCADA and analyse its architectures

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **7 HOURS**

What is a plc, technical definition of plc, what are its advantages, characteristics functions of a plc, chronological evolution of plc, types of plc, unitary plc, modular plc, small plc, medium plc, large plc, block diagram of plc: input/output (i/o) section, processor section, power supply, memory central processing unit: processor software / executive software, multi-tasking, languages, ladder language

Teaching-Learning Process	9. PowerPointPresentation, 10. Videodemonstration. 11. ChalkandTalk 12. LaboratoryDemonstrationsandPracticalExperiments

MODULE-2 **7 HOURS**

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder

Teaching-Learning Process	1. PowerPointPresentation, 2. Videodemonstration. 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-3 **10 HOURS**

PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Countdown (CTD).

Advanced instructions: Introduction: Comparison instructions, discussions on comparison instructions, "EQUAL" or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LESS" instruction, "LESS THANOR EQUAL' or "LEQ" instruction, GREATER THAN" OR "GRT" instruction, "GREATER THAN OR EQUAL TO" or "GRO" instruction, "MASKED COMPARISON FOR EQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.

Teaching-Learning Process	1. PowerPointPresentation, 2. Videodemonstration. 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE-4	**8 HOURS**
PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems. Sinking and sourcing. Discrete input module. Rectifier with filter, threshold detection, Isolation, logic section, specifications of discrete input module, types of analog input module, special input modules, analog output module, I/O modules in hazardous locations power supply requirements, power supply configuration, filters.	
Teaching-Learning Process	1. PowerPointPresentation, 2. Videodemonstration. 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

MODULE 5	**8 HOURS**
Introduction, definition and history of Supervisory Control and Data Acquisition typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First Generation-Monolithic, Second Generation-Distributed, Third Generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical.	
Teaching-Learning Process	1. PowerPointPresentation, 2. Videodemonstration. 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Design PLC ladder diagram for basic gate operation
2	Interfacing of Lamp & button with PLC for ON&OFF Operation. Verify all logic gates.
3	Design PLC ladder diagram for De-Morgan's theorem
4	Design PLC ladder diagram for 4:1 MUX and 1:4 DE-MUX
5	Design PLC ladder diagram for ON delay timer for ON/OFF controller of motor
6	Design PLC ladder diagram for OFF delay timer for ON/OFF controller of motor
7	Design PLC ladder diagram for UP COUNTER for ON/OFF controller of motor
8	Design PLC ladder diagram for DOWN COUNTER for ON/OFF controller of motor
9	Design PLC ladder diagram for ON and OFF delay timer for ON/OFF controller of motor with Micro Logix 1400
10	Design PLC ladder diagram for UP COUNTER and DOWN COUNTER for ON/OFF controller of motor with Micro Logix 1400
11	DesignPLC based temperature sensing using RTD

12	Design parameter reading of PLC in SCADA
13	Designtemperature sensing using SCADA

Course outcomes (Course Skill Set):

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

CO1. Demonstrate the concepts of basic programming skills of PLC using logical instructions

CO2. Apply the architecture process involved in programmable logic controller and basic programming skills of PLC using logical instructions

CO3. Examine the various operation involved in the PLC input/output module and SCADA system

CO4. Construct the ladder diagram for PLC using logical instructions, timer and counters, Data Handling instructions and build the SCADA System for Real time industrial process.

CO5. Develop the Logical Instructions Involved in development of programmable logic controller for various operations

CO6. Construct the ladder logic for various operations using PLC and SCADA for Industrial Environment

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 40% of the maximum marks (20 marks). 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 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 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

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **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 **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

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

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

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% 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 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. "PLC and Industrial application", MadhuchhandanGupts and SamarjitSen Gupta, pernram international pub. (Indian) Pvt. Ltd., 2011.
2. Ronald L Krutz, "Securing SCADA System", Wiley Publication

REFERENCE BOOKS

1. GaryDunning,"Introduction to Programmable Logic Controllers", Thomson,2nd Edition.
2. John W Webb, Ronald A Reis,"Programmable Logic Controllers: Principles and Application", PHI Learning, Newdelhi, 5 th Edition
3. Stuart A Boyer, "SCADA Supervisory Control and Data Acqusition", ISA, 4 th Revised edition

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

- Group activity
- Quiz
- Presentation

INDUSTRIAL ROBOTICS			
Course Code	**21MT63**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

CLO1. To gain knowledge on basics of Robotics

CLO2. To understand Robot Kinematics and Dynamics, Sensors used in Robots

CLO3. To understand basics of Robot programming and Artificial Intelligence

CLO4. To gain knowledge on robot layout and cell design

CLO5.To relate the knowledge on robotics and understand the application of Robots in Industries

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

6. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
7. ChalkandTalkmethodforProblemSolving.
8. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
9. Adoptcollaborative(GroupLearning)Learningintheclass.
10. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1

8 HOURS

Fundamentals of Robotics: robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot programming and work cell control, robot applications, problems. Basic control systems and components: Basic control systems concepts and models, control system analysis, robot sensors and actuators.

Teaching-Learning Process	8. Power-pointPresentation, 9. Videodemonstration 10. ChalkandTalkareusedforProblemSolving (In-general).

Module-2

8 HOURS

Robot Motion Analysis: Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, D-H convention, manipulator path control, robot dynamics, configuration of a robot controller.

Robot End Effectors: types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems.

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics, problems.

Teaching-Learning Process	4. Power-pointPresentation, 5. Videodemonstration 6. ChalkandTalkareusedforProblemSolving (In-general).

Module-3

8 HOURS

Robot Programming: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods, problems.

Artificial Intelligence (AI): Introduction & goals of AI in research, AI techniques, LISP programming, AI & robotics, LISP in factory, robotic paradigms, problems.

Teaching-Learning Process	4. Power-pointPresentation, 5. Videodemonstration 6. ChalkandTalkareusedforProblemSolving (In-general).

Module-4	
8 HOURS	
Robot Cell Design & Control: Robot cell layouts, multiple robots and machine interference, considerations in work -cell design, work-cell control, interlocks, error detection andrecovery, work -cell controller, robot cycle time analysis, graphic simulation of robotic work cells, problems.	
Teaching-Learning Process	4. Power-pointPresentation, 5. Videodemonstration 6. ChalkandTalkareusedforProblemSolving (In-general).
Module-5	
8 HOURS	
Robots in Automatic Processing Operations: Introduction, spot welding, continuous arc welding, spray coating, other processing operations. **Assembly & Inspection**: Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote centre compliance (RCC) device, assembly system configurations, adaptable programmable assembly system, designing for robotic assembly, inspection automation.	
Teaching-Learning Process	4. Power-pointPresentation, 5. Videodemonstration 6. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

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

CO 1. To understand the basics of robotics, sensors, Programming and Applications of Robots

CO 2. To illustrate the different applications of robotics in Industries

CO 3. To analyze simple robot kinematics and dynamics

CO 4. To design general robot cell layouts

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, and DavideScaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, PHI, 2011.

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

- Industrial visit to understand the importance of robots in Industries

POWER ELECTRONICS			
Course Code	**21MT641**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:
CLO 1. To study and understand the importance of power electronics circuits and their applications.
CLO 2. To understand the construction, working, and switching characteristics of various power devices.
CLO 3. Learn the applications of power devices in AC voltage regulators, controlled rectifiers, choppers and inverters
CLO 4. Analyze their working under various load conditions.
CLO 5. To familiarize with the performance parameters of controlled rectifiers, chopper and inverters.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.

Module-1

8 HOURS

Module–1: Introduction, Power semiconductor Devices: Applications of Power Electronics Power semiconductor devices, Control Characteristics, Types of power electronics circuits, Peripheral effects. Power MOSFETs – switching characteristics, gate drive, di/dt and dv/dt limitations, Isolation of gate and base drives, Simple design of gate and base drives.

Teaching-Learning Process	Power Pointpresentations ChalkandTalkmethodforProblemSolving.

Module-2

8 HOURS

Thyristors: Introduction, characteristics, Two Transistor Model. Turn-on and turn-off, di/dt and dv/dt protection, Thyristor types, Thyristors firing circuits, Simple design of firing circuits using UJT.
Commutation Techniques: Introduction. Natural Communication, Forcedcommutation: self-commutation, impulse commutation, resonant pulse commutation and complementary commutations.

Teaching-Learning Process	Power Pointpresentations ChalkandTalkmethodforProblemSolving.

Module-3

8 HOURS

AC Voltage Controllers: Introduction. Principle of ON-OFF and phase control. Single-phase bidirectional controllers with resistive and inductive loads.
Controlled Rectifiers: Introduction. Principle of phase controlled converter operation. Single phase semi-converters. Full converters. Three-phase half-wave converters. Three-phase full-wave converters.

Teaching-Learning Process	Power Pointpresentations ChalkandTalkmethodforProblemSolving.

Module-4

8 HOURS

DC Choppers: Introduction. Principle of step-down and step-up chopper with R-L load. Performance parameters. Choppers classification. Analysis of impulse commutated thyristor chopper (only qualitative analysis)

Teaching-Learning Process	Power Pointpresentations ChalkandTalkmethodforProblemSolving.

Module-5

8 HOURS

Inverters: Introduction, Principle of operation. Performance parameters. Single-phase bridge inverters. Three phase inverters. Voltage control of single-phase Inverters single pulse width, multiple pulse width, and sinusoidal pulse width modulation.

Teaching-Learning Process	Power Pointpresentations ChalkandTalkmethodforProblemSolving.

Course outcome (Course Skill Set)

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

CO1. Have knowledge of semiconductors devices, Thyristors, AC voltage controllers, choppers and inverters

CO2. Understand the characteristics and working principles of Thyristors, AC voltage controllers, choppers and inverters.

CO3. Apply control techniques to meet the desired operation of AC voltage regulators, rectifiers and commutation.

CO4. Apply control techniques to meet the desired operation of coppers and Inverters.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Power Electronics: Circuits Devices and Applications Mohammad H Rashid, Pearson 4th Edition, 2014

Reference Materials

1 Power Electronics: Converters, Applications and Design Ned Mohan et al Wiley 3rd Edition, 2014
2 Power Electronics: Daniel W Hart McGraw Hill 1 st Edition, 2011
3 Elements of Power Electronics :Philip T Krein Oxford Indian Edition, 2008

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

- Quiz
- Presentation
- Group Activity

SMART FACTORY AND INDUSTRY 4.0			
Course Code	**21MT642**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

CLO1. Understand the basics of smart factory and Manufacturing

CLO2. Gain knowledge on different tools of smart design and fabrication

CLO3. Understand basics of smart applications

CLO4. Understanding Internet of things in Industries

CLO5.Concepts of smart and empowered workers in Industries

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

11. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
12. ChalkandTalkmethodforProblemSolving.
13. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
14. Adoptcollaborative(GroupLearning)Learningintheclass.
15. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1 **8 HOURS**

Introduction to Smart Manufacturing - Dimensions -Demand-Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); Real-Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization, and reduction of GHG).

Teaching-Learning Process	11. Power-pointPresentation, 12. Videodemonstration 13. ChalkandTalkareusedforProblemSolving (In-general).

Module-2 **8 HOURS**

Smart Design/Fabrication: Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor Networks and Devices.

Teaching-Learning Process	7. Power-pointPresentation, 8. Videodemonstration 9. ChalkandTalkareusedforProblemSolving (In-general).

Module-3 **8 HOURS**

Smart Applications: Online Predictive Modeming, Monitoring, and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities,

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-4 **8 HOURS**

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Service, Cloud Computing and Industry 4.0, Data acquisition mechanisms, Data interpretation techniques and tools, Development of feedback systems.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration

	3. ChalkandTalkareusedforProblemSolving (In-general).

Module-5

8 HOURS

Smart and Empowered Workers: Eliminating Errors and Omissions, Deskilling Operations, Improving Speed/Agility, Improving Information Capture/Traceability, Improving Intelligent Decision Making under uncertainty Assisted/Augmented Production, Assembly, Quality control, Maintenance, Warehouse Operations, and Assisted Training.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

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

CO 1. To understand the concepts of smart design and manufacturing in Industries

CO 2. To know the importance of different components of smart factory systems

CO 3. To apply the concepts of Internet of Things technology in Industry

CO 4. To analyze the production and logistics process in Smart factory system

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(To have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Michael Deng, Colin Koh, Smart Factory: Transforming Manufacturing for Industry 4.0 (Industry 4.0 in

ASEAN Region Series)-ISBN-13: 979-8583886425.
2. Banken, and Alasdair Gilchrist; Industry 4.0, Apress Berkeley, CA, ISBN978-1-4842-2047-4
3. Carlos Toro, Wei Wang, and Humza Akhtar, Implementing Industry 4.0, Springer Cham, ISBN978-3-030-67269-0.
4. Erwin Rauch and Manuel Woschank, Industry 4.0 for SMEs - Smart Manufacturing and Logistics for SMEs, ISBN 978-3-03936-567-8.

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

- Industrial visit to gain knowledge on smart factory and Industry 4.0
- Projects involving Internet of things in industrial models

AUTOMOTIVE ELECTRONICS AND HYBRID VEHICLES			
Course Code	**21MT643**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

CLO 1. To Gain knowledge of Ignition, Transmission, Brakes System in Automobile

CLO 2. To Understand the basic concepts and various Operation using Sensor and Actuators Used Automobile.

CLO 3. To diagnosis the problem related types of, Data Acquisition System and Communication Networks (Bus Systems) Control system using Standard Technology.

CLO 4. To Understand the basic of Vehicle Cruise control and Collision Avoidance Radar warning Systems.

CLO 5. To Gain knowledge of Electric Vehicle, Hybrid Electric vehicle, Electric Hybrid Vehicle,Vehicle components

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

8 HOURS

Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control, Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System. Air/Fuel Systems Fuel handling. Air/ Fuel Management.

Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Module-2

8 HOURS

Sensors and actuators: Sensors – Oxygen (02/EGO) Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position (CKP)Sensors, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Manifold Absolute Pressure (MAP) Sensor– Strain gauge and Capacitor capsule, Engine Coolant Temperature (ECT) Sensor, IntakeAirTemperature(IAT)Sensor,KnockSensor,Airflowratesensor, Throttleangle Sensor. Actuators: Fuel Metering Actuator, Fuel Injector, Ignition Actuator.Exhaust After-Treatment Systems – AIR, Catalytic Converter, Exhaust GasRecirculation(EGR),EvaporativeEmissionSystems.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-3

8 HOURS

Automotive Instrumentation and Communication: Sampling, Measurement & Signal Conversion of various parameters (Speed, fuel, pressure). Serial Data, Communication Systems, Protection, Body and Chassis is Electrical Systems, Remote Keyless Entry, GPS

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-4

8 HOURS

Vehicle Motion Control: Cruise control, Chassis, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, electronically controlled suspension. Automotive Diagnostics –Timing Light, Engine Analyzer, On- board diagnostics, Off-board diagnostics, Expert Systems.Future Automotive Electronics Systems: Alternative Fuel Engines, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Radio navigation, Advance Driver
Information System.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-5

8 HOURS

Introduction to Alternative Vehicles: Electric Vehicle, Hybrid Electric vehicle, Electric Hybrid Vehicle, Vehicle components, Electric and Hybrid history EV/CEV Comparison. Alternative Vehicle Architecture: Electric Vehicles, Hybrid Electric Vehicles, Plug-in Hybrid Electric Vehicles, Power Train component Sizing, Mass Analysis & Packaging, Vehicle Simulation

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Course outcome (Course Skill Set)

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

- **CO 1.** Understanding of Engine Parameters and a critical awareness of current problems within the automotive electronics domain using Various Measurement Technology.
- **CO 2.** Apply the fundamental Concepts of automotive electronics on various Engine parts, Sensor, Actuator, Communication and Measurement System.
- **CO 3.** Determine the extent and nature of electronic circuitry in automotive systems including monitoring and control circuits for engines, transmissions, brakes, steering, suspension
- **CO 4.** Analyze climate control, instrumentation and radios and accessories involved in Automotive Industry.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1.Willliam B. Ribbens: Understanding Automotive Electronics, 6th Edition, SAMS/ElsevierPublishingIqbal Husain "Electric and Hybrid Vehicles: Design fundamentals". CRC Press,2011.

2.**RobertBoschGmbH:**AutomotiveElectronicsSystemsandComponents5thEdition,JohnWiley&SonsLtd.,2007

3.JamesLaminie and John Lowry. "Electric Vehicle Technology – Explained', CRC Press2010. Societyof AutomobileEngineers, "HybridElectricvehicles",CRC Press,2011.

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

- Quiz
- Presentations
- Group activity

Signal Processing			
Course Code	**21MT644**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3: 0 :0 : 1	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

The course aims to enable the students to:

- **CLO 1.** Understand the various aspects of signals and systems.
- **CLO 2.** Compute the response of discrete-time Linear and Time-Invariant Systems
- **CLO 3.** Represent the discrete-time signals and systems in frequency domain
- **CLO 4.** Design analog and digital filters for signal processing.

Teaching-Learning Process (General Instructions)

1. These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.
2. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes
3. Show Video/animation films to explain the functioning of various
4. Encourage collaborative (Group) Learning in the class to promote critical thinking
5. Topics for seminars on several MEMS related topics and their applications
6. Encourage the students to take up mini projects and main projects
7. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction: Signals and Systems-Definition and Examples, Basic Elements of a Digital Signal Processing System, Advantages of Digital Signal Processing over Analog Signal Processing, Classification of Signals, The Concept of Frequency in Continuous-Time and Discrete-Time Signals, Analog to Digital Conversion (Block Diagram Discussion)

Discrete-Time Signals: Elementary Discrete-Time Signals, Classification of Discrete-Time signals, Manipulation of Discrete-time Signals

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Module-2

Discrete-Time Systems: Input-Output Description of Systems, Block Diagram Representation, Classification of Systems (From Text-1)

Analysis of Discrete-Time Systems: Representation of Discrete-Time Signals using Impulses, Response of LTI Systems-Convolution Sum, Properties of Convolution Sum and Interconnection of LTI systems, Stability and Causality of LTI Systems, Difference Equation Representation of LTI systems

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Module-3

Z-Transforms: Definition, Properties, Rational Z-Transforms, Inverse Z-Transforms (Partial Fraction Expansion, Long Division methods), Analysis of LTI systems in Z-domain (Stability and Causality), Relationship between Impulse Response, System Function and Difference Equation Representation

Teaching-Learning Process	Chalk and talk method, Power Point Presentations **RBT Level:** L1, L2, L3

Module-4

Design of FIR Filters: Characteristics of practical frequency-selective filters, Design of Linear-phase FIR (low pass and High pass) filters using windows – Rectangular and Hamming windows. Structure for FIR Systems: Direct

form, Cascade form	
Teaching-Learning Process	Chalk and Talk Method, You Tube Videos **RBT Level:** L1, L2, L3
Module-5	
IIR Filter Design: Infinite Impulse response Filter Format, Bilinear Transformation Design Method, Analog Filters using Low pass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation Design Procedure, Digital Butterworth (Lowpass and Highpass) Filter Design using BLT. Realization of IIR Filters in Direct form I and II, Cascade and Parallel forms	
Teaching-Learning Process	Power Point Presentation, **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

- **CO1.** Classify the signals.
- **CO2.** Perform operations on discrete-time signals, and classify the systems.
- **CO3.** Compute the response and determine the properties of LTI systems using Z-transforms.
- **CO4.** Design FIR and IIR Digital Filters.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Book:

John G Proakis and Dimitris G Manolakis, "Digital Signal Processing", Pearson, 4th Edition, 2012.

Reference Books:

1. Alan V Oppenheim and Ronald W Schafer, "Discrete Time Signal Processing", Pearson, 3rd Edition, 2014.
2. S Salivahanan, "Digital Signal Processing", Mc Graw Hill Education, 3rd Edition, 2017.

Activity Based Learning (Suggested Activities)/ Practical Based learning

To be conducted using MATLAB or any computational tool:

(i) Generate standard signals and plot them
(ii) Obtain Z-transform of step-sequence, exponential sequence and sinusoidal sequence
(iii) Perform Linear convolution of two sequences and verify commutative, distributive and associative laws
(iv) Design and implementation of IIR (Butterworth) low pass filter to meet given specifications.
(v) Design and implementation of IIR (Butterworth) high pass filter to meet given specifications.
(vi) Design and implementation of low pass FIR filter to meet given specifications.
(vii) Design and implementation of high pass FIR filter to meet given specifications.

AUTOMATION IN MANUFACTURING			
Course Code	**21MT651**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: ToGain the knowledge of

CLO 1. Gain knowledge of fundamental concepts of automation in manufacturing.
CLO 2. Understand the techniques of industrial control and quality control in manufacturing.
CLO 3. Understand automated manufacturing and support system for industry operations.
CLO 4. Gain knowledge of inspection technologies.
CLO 5. Understand group technologies and flexible manufacturing systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

5. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
6. Encouragecollaborative(Group)Learningintheclass
7. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
8. Project based learning: AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

Module-1

8 HOURS

Introduction: Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles & Strategies. **Manufacturing Operations:** Manufacturing Operations, Product/Production Relationship, Production concepts and Mathematical Models & Costs of Manufacturing Operations.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation,

Module-2

8 HOURS

Industrial Control System: Basic Elements of an Automated System, Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control. **Quality Control Systems:** Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering. Introduction to SQC Tools.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, simulation of programs.

Module-3

8 HOURS

Automated Manufacturing Systems: Components of a Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells. **Manufacturing Support System:** Process Planning, Computer Aided Process Planning, Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Module-4

8 HOURS

Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools. **Machine Vision**, optical Inspection Techniques & Noncontact Non-optical Inspection Technologies.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation,

Module-5

	8 HOURS
Group Technology & Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing. **Flexible Manufacturing Systems:** What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Course outcome (Course Skill Set)

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

CO 1. Gain knowledge of fundamental concepts of automated flow lines, traditional and modern quality control methods.

CO 2. Gain knowledge ofmanufacturing supporting system, AMS, Inspection Technologies, group technologies, and FMS.

CO 3. Understand various automated flow lines, assembly systems and line balancing methods.

CO 4. Understand importance of automated material handling and storage systems and the importance of adaptive control systems, automated inspection systems.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

TextBooks:

Recommended Text Books

3. Automation, Production Systems and Computer Integrated Manufacturing, M. P. Groover, Pearson education. Third Edition,2008
4. Principles of CIM, Vajpayee, PHI.

Reference Books:

5. Anatomy of Automation, Amber G.H & P. S. Amber, Prentice Hall.

6. Performance Modeling of Automated Manufacturing Systems, Viswanandham, PHI
7. Computer Based Industrial Control, Krishna Kant, EEE-PHI.

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

- Quiz
- Group activity
- Presentation

ELECTRIC AND HYBRID VEHICLE			
Course Code	**21MT652**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course learning objectives:
CLO 1. To gain knowledge of Performance characteristics of road vehicle and motors.
CLO 2. To understand Hybrid Architecture configuration and operation of AC motors
CLO 3. To understand Hybrid Power Plant specifications and engine fraction-engine downsizing
CLO 4. To understand Energy Storage Technology.
CLO 5. To understand concepts of fuel cells.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
2. Encouragecollaborative(Group)Learningintheclass
3. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
4. Project based learning: AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

Module-1 **8 HOURS**

Introduction: Performance characteristics of road vehicles, calculation of road load, predicting fuel economy, Grid connected hybrids
DC motors: Series wound, shunt wound. Compound wound and separately excited.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-2 **8 HOURS**

AC motors: Induction, synchronous, brushless DC motor, switched reluctance motors.
Hybrid Architecture: Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT). Wheel motor.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-3 **8 HOURS**

Hybrid Power Plant specifications: Grade and cruise targets. Launching and boosting, braking and energy recuperation drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-4 **8 HOURS**

Sizing the Drive System: Matching electric drive and ICE, sizing the propulsion motor, sizing power Electronics

Energy Storage Technology: Battery basics, different types of batteries (lead-acid battery / Lithium / Alkaline), High discharge capacitors, flywheels, battery parameters.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-5

8 HOURS

Fuel cells: Fuel cell characteristics, fuel cell types - alkaline fuel cell, proton exchange membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Course outcome (Course Skill Set)

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

CO1. Understanding the working principle of hybrid vehicle and its main components, operating principle and properties of the most common types of electrical motors in hybrid technology.

CO2. Illustrate power storage system and fuel cells in electric vehicles.

CO3. Analyze the performance of a hybrid vehicle.

CO4. Analyze Hybrid Architecture drive system, power system and fuel cells in Hybrid electric vehicle.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. The Electric Car: Development & Future of Battery, Hybrid &Fuel-Cell Cars - Dr Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data, UK, ISBN0 85296 0131.
2. Electric and Hybrid Vehicles - Robin Hardy, Iqbal Husain, CRC Press, ISBN 0-8493-1466-6.

3. Propulsion Systems for Hybrid Vehicles - John M. Miller, Institute of Electrical Engineers, London, ISBN0 863413366.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Hand Book of Electric Motors - Hamid A Taliyat, Gerald B Kliman, Mercel Dekker Inc., US, ISBN0-8247-4105-6

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

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

- Quiz
- Group activity
- Presentation

Mechatronics Engineering.			
Course Code	**21MT653**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

CLO 1: Togainknowledgeofmeasurement in control system in mechatronics engineering.
CLO 2: To understand the working and applications of transducers and sensors.
CLO 3: To gain the knowledge in signal conditioning, mechatronics, engineering.
CLO 4: To Gain the knowledge of electromechanical components and the operations of PLC.
CLO 5: To Understand mechatronics design process and its applications?

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Show Video/animation films to explain the functioning of elements of Robotics
2. Encourage collaborative (Group)Learning in the class
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Adopt Problem Based Learning(PBL),which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

Module-1

Introduction: Scope and elements of mechatronics, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-2

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Teaching-Learning Process	5. . PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Module-3

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Module-4	
Electro Mechanical Drives: mechanical systems. Types of motions. Electrical systems. Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation. **Programmable Logic Controller**: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.	
Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments
Module-5	
Mechatronics Design process: Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics. Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	
Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments
Course outcome (Course Skill Set) At the end of the course the student will be able to: **CO 1:** Illustrate various components of Mechatronics systems. **C0 2:** explain the working principles of transducers and sensors in mechatronics. **CO 3:** Apply the knowledge of electromechanical components and PLC in mechatronics applications. **CO 4:** Outline the design process in mechatronics and Mechatronics integrated issues.	

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005
2. Mechatronics-Principles Concepts and Applications NitaigourPremchanMahalik Tata McGraw Hill 1stEdition, 2003.
3. Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008
4. Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. Second edition

Web links and Video Lectures (e-Resources):

- NPTEL courses on mechatronics (https://archive.nptel.ac.in/noc/noc_course.html)

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

- Quiz
- Presentations
- Group activity

MICRO ELECTRO-MECHANICAL SYSTEMS			
Course Code	**21MT654**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

CLO 1. Understand the operation and Importance of Micro and Smart Systems.
CLO 2. Understand the Working Principle and Operation of Various Kinds of Sensors and Actuators.
CLO 3. Understand the Fabrication Process of Micromachining.
CLO 4. Understand the operation of Electronics Circuits for Micro and Smart Systems.
CLO 5. Understand the Working Principle of Controllers for MEMS and BEL Pressure Sensor and Smart Structure in vibration control.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

8. Power Point Presentation,
9. Chalk and Talk are used for Derivations and Correlations (In-general).
10. Video demonstration or Simulations, Laboratory Demonstrations and Practical Experiments.

Module-1 **8 HOURS**

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.

Teaching-Learning Process	5. Power Point Presentation, 6. Chalk and Talk are used for Derivations and Correlations (In-general). 7. Video demonstration or Simulations. 8. Laboratory Demonstrations and Practical Experiments.

Module-2 **8 HOURS**

Micro and Smart Devices and Systems: Principles and Materials:Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, Piezoresistive pressure sensor, Portable blood analyzer, Conductometric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations. 4. Laboratory Demonstrations and Practical Experiments.

Module- 3 **8 HOURS**

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachining bulk micromachining. Specialized Materials for Microsystems.

Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations. 4. Laboratory Demonstrations and Practical Experiments.

Module-4 **8 HOURS**

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode, Tunnel diode, Bipolar Junction Transistor (BJT), MOSFET, and CMOS circuits: Inverter and NAND Gate, Electronics Amplifiers: Operational Amplifiers, Basic Op-Amp circuit, Op-Amp based circuits.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations. 4. Laboratory Demonstrations and Practical Experiments.
Module-5	**8 HOURS**
Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems. Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.	
Teaching-Learning Process	1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations. 4. Laboratory Demonstrations and Practical Experiments.

Course outcome (Course Skill Set)

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

CO7. Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.

CO8. Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.

CO9. Examine the behavior of piezoresistive& piezoelectric materials required to fabricate pressure sensor & vibration control structures.

CO10. Measure the performance of pressure sensor & vibration control structure in real time 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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2.Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
3. MEMS- NitaigourPremchandMahalik, TMH 2007.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

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

1. Students are segregated in groups of 5members made to Prepare models of FCC structure of Silicon and Patterns to demonstrate the process of Photolithography.
2. Students are segregated in groups of 5members made to Prepare models of Cantilever Beam to analyze the vibration control and Patterns to demonstrate the process of Etching.
3.Quiz

THERMAL ENGINEERING			
Course Code	**21MT71**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students to,
CLO 1. Gain fundamental concepts of thermodynamics.
CLO 2. Apply the first and second laws of thermodynamics.
CLO 3. Gain fundamental knowledge of air standard cycle and heat transfer
CLO 4. Formulate and determine conduction and convection heat transfer.
CLO 5. Determine convection and radiation heat transfer.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

9. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
10. Encouragecollaborative(Group)Learningintheclass
11. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
12. Project based learning: AdoptProblemBasedLearning(PBL),whichfostersstudents'Analyticalskills,developthinking skills such as the ability to evaluate, generalize, and analyze information rather thansimplyrecall it.

Module-1 **8 HOURS**

Thermodynamics - Fundamental Concepts & Definitions: Thermodynamics: definition and scope, Microscopic and Macroscopic approaches. Engineering thermodynamics: definition, some practical applications of engineering thermodynamic. System (Closed system) and Control Volume (open system): Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, L1, L2, L3 quasi-static process, cyclic and non-cyclic presses; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Statement of Zeroth law of thermodynamics. (No Numericals).

Work and Heat: Thermodynamic definition of work; examples, sign convention. Displacement work: at part of a system boundary, at whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work, Electrical work. Other types of work, Heat; definition, units and sign convention, simple problems

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation,

Module-2 **8 HOURS**

First Law of Thermodynamics: Statement of the First law of thermodynamics, extension of the First law to non-cyclic process, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, simple problems.

Second Law of Thermodynamics: Thermal Reservoir, Concepts of Heat Engine, Heat Pump, coefficients of performance. Keivin – Planck statement of the Second law of Thermodynamics; PMM II and PMM I, Claussius statement of second law of Thermodynamics, equivalence of the two statements; reversible hat engines, Carnot cycle, Carnot principles. Thermodynamic temperature scale, simple problems.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, solving the simple problems.

Module-3 **8 HOURS**

Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles, simple problems**.** **Heat Transfer - Introductory Concepts and Definitions:** Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanics. Boundary conditions of 1st, 2nd and 3rd Kind, simple problems.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.
Module-4 **8 HOURS**	
Conduction: Derivation of general three dimensional conduction equations in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls. Overall heat transfer coefficient. Thermal contact resistance, Simple problems. **Free or Natural Convection:** Application of dimensional analysis for free convection- physical significance or Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Simple problems.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.
Module-5 **8 HOURS**	
Forced Convections: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers, Simple problems. **Radiation Heat Transfer: T**hermal radiation; definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kircoff's law. Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surface, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle, Simple problems.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.
Course outcome (Course Skill Set) At the end of the course the student will be able to: **CO1**. Understand the concepts of system, properties, energy interaction, laws of thermodynamics, and heat transfer, and boundary conditions. **CO2**. Apply laws of thermodynamics and laws of heat transfer to engineering system. Define the thermodynamic process and cycle. Determine the energy interaction. **CO3**. Develop heat conduction and temperature distribution equation and describe thermal resistance concept. Determine the rate of heat transfer and temperature at any point in the heat transfer domain. **CO4**. Dimensional analysis of heat transfer and use of dimensional number. Study the effect of contact resistance and addition of insulation.	

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

TextBooks:

Recommended Text Books

8. Basic and applied Thermodynamics, P. K. Nag, Tata McGraw Hill Pub. 2002.
9. Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002.

Reference Books:

10. Engineering Thermodynamics, J. B. Jones and G. A. Hawkins, John Wiley and Sons.
11. Basic Engineering Thermodynamics data hand book by B. T. Nijaguna. (To be supplied in the examination)
12. Thermodynamics, An Engineering approach, Yunus a. Cenegal and Michael a.Boles, Tata McGraw Hill publications, 2002.
13. Heat transfer, P. K. Nag, Tata Mc Graw Hill 2002.
14. Heat transfer, a practical approach, Yunus a- Cengel Tata Mc Graw Hill.
15. Heat & Mass transfer, Tirumaleshwar, Pearson education 2006.

Communication Systems			
Course Code	**21MT72**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:0:0:1	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	2	Exam Hours	3

Non-MCQ pattern of CIE and SEE

Course Learning objectives This course will enable students to:

CLO 1. Understand the analog and digital communication systems.
CLO 2. Describe Amplitude, Frequency & Phase modulations, and Amplitude demodulation.
CLO 3. Analyze the working of digital modulation techniques and compare the different schemes.
CLO 4. Present the basic concepts of wireless and cellular communications.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

17. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
18. Show Video/animation films to explain the functioning of various techniques.
19. Encourage collaborative (Group) Learning in the class
20. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
21. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
22. Topics will be introduced in multiple representations.
23. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
24. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to Electronic Communications: Historical perspective, Electromagnetic frequency spectrum, Signal and its representation, Elements of electronic communications system, primary communication resources, Analog and digital transmission, Modulation (Text 1: Chapter 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Module-2

Amplitude Modulation Techniques: Types of analog modulation, Principle of amplitude modulation, Limitations of AM (TEXT 1: Chapter 4)

Angle Modulation Techniques: Principles of Angle modulation, Theory of FM-basic Concepts, Theory of phase modulation (TEXT1: Chapter 5)

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Module-3	
Pulse Modulation Techniques: Digital Versus Analog Transmissions, Sampling Theorem, Classification of pulse modulation techniques, PAM, PWM, PPM, PCM, Quantization of signals (TEXT 1: Chapter 7)	
Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3
Module-4	
Digital Modulation Techniques: Types of digital Modulation, ASK, FSK, PSK, QPSK. (TEXT 1: Chapter 9)	
Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3
Module-5	
Evolution of wireless communication systems: Brief History of wireless communications, Advantages of wireless communication, disadvantages of wireless communications, wireless network generations, Comparison of wireless systems, Evolution of next generation networks, Applications of wireless communication (TEXT 2: Chapter 1) **Principles of Cellular Communications:**Cellular terminology, Cell structure and Cluster, Frequency reuse concept, Cluster size and system capacity (TEXT 2: Chapter 4)	
Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

CO5. Describe the concepts of communication systems.

CO6. Relate to the AM and FM modulation techniques.

CO7. Understand the process of sampling and describe different methods to generate digital signals.

CO8. Describe the basic digital modulation techniques.

CO9. Compare the wireless communication systems and describe cellular communication.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE will be the same as other core theory courses**.**

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 (SEE):

For non-MCQ pattern of CIE and SEE

Continuous Internal Evaluation (CIE):

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of CIE for the course.

Three Unit Tests each of **20 Marks (duration 01 hour**)

10. First test at the end of 5th week of the semester
11. Second test at the end of the 10th week of the semester
12. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

13. First assignment at the end of 4th week of the semester
14. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

15. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

4. The question paper will have ten questions. Each question is set for 20 marks.
5. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. T L Singal, Analog and Digital Communications, McGraw Hill Education (India) Private Limited, 2012, 0-07-107269-1
2. T L Singal, Wireless Communications, McGraw Hill Education (India) Private Limited, 2016, ISBN:0-07-068178-3.

Digital Image Processing and Robot Vision			
Course Code	**21MT731**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives

- **CLO 1.** Understand the fundamentals of digital image processing.
- **CLO 2.** Understand the image enhancement techniques in spatial domain used in digital image processing.
- **CLO 3.** Understand the Color Image Processing and frequency domain enhancement techniques in digital image processing.
- **CLO 4.** Understand the image compression techniques and methods used in digital image processing.
- **CLO 5.** Relate to the vision techniques used in robotics.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Show Video/animation films to explain the functioning of various image processing concepts.
2. Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
3. Encourage students to ask questions and investigate their own ideas helps improve their problem-solving skills as well as gain a deeper understanding of academic concepts.
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Students are encouraged to do coding based projects to gain knowledge in image processing.
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in multiple representations.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Digital Image Processing Fundamentals: What is Digital Image Processing?, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Elements of an Image Processing System, **Digital Image Fundamentals:** Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Tonal and Spatial Resolutions, Image File Formats: BMP, TIFF and JPEG. RGB Color model. **Text 1**

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Videos on Image processing applications **RBT Level:** L1, L2, L3

Module-2	
Enhancement in Spatial Domain: Some Simple Intensity Transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters Frequency domain image enhancement techniques. **Text 1**	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3
Module-3	
Frequency Domain: Basics of Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters. **Color Image Processing:** Color Fundamentals, Color Models, Pseudo-color Image Processing. **Text 1**	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, **RBT Level:** L1, L2, L3
Module-4	
Image Compression Fundamentals: Coding Redundancy, Inter-pixel Redundancy, Psycho visual Redundancy Lossless Compression Techniques: Run Length Coding, Huffman Coding, Lossy Compression Techniques: Predictive Coding, Improved Gray Scale Quantization, Transform Coding, JPEG Standard. **Text 1**	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3
Module-5	
Low-level vision: optical sensors, camera models, camera geometry in homogeneous coordinates, intensity transformations, thresholding, basic spatial domain image processing techniques such as edge operators and gradients. **High-level vision**: Image segmentation, optimum thresholding, region and edge based segmentation, split-merge techniques, feature extraction including boundary and region descriptors, three-dimensional image segmentation, pattern recognition and scene interpretation. **Text 2**: Chapters 7 & 8 (Note: Use only the theory portion, avoid mathematical derivations & descriptions from Text 2)	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

- **CO1.** Understand the fundamental concepts of image processing.
- **CO2.** Conduct independent study and analysis of Image Enhancement techniques.
- **CO3.** Apply image processing techniques in frequency (Fourier) domain.
- **CO4.** Describe the image compression techniques.
- **CO5.** Discuss the low-level and high-level vision concepts applied in robotics vision.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

16. First test at the end of 5th week of the semester
17. Second test at the end of the 10th week of the semester
18. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

19. First assignment at the end of 4th week of the semester
20. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

21. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

6. The question paper will have ten questions. Each question is set for 20 marks.
7. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

7. Digital Image Processing- Rafael C Gonzalez and Richard E Woods, PHI, 3rd Edition 2010.
8. Robotics: Control, Sensing, Vision, and Intelligence, K S Fu, R C Gonzalez, and C S G Lee, McGraw-Hill

Reference Book:

Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.

Web links and Video Lectures (e-Resources)

- Image databases, https://imageprocessingplace.com/root_files_V3/image_databases.htm
- Student support materials, https://imageprocessingplace.com/root_files_V3/students/students.htm
- NPTEL Course, Introduction to Digital Image Processing, https://nptel.ac.in/courses/117105079
- Computer Vision and Image Processing, https://nptel.ac.in/courses/108103174
- Image Processing and Computer Vision – Matlab and Simulink,
- https://in.mathworks.com/solutions/image-video-processing.html

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

- Simulink models for Image processing.

Digital Controllers			
Course Code	**21MT732**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives

CLO 1. To develop the understanding of fundamental principles of digital control systems.
CLO 2. To disseminate the concept of stability and its assessment for discrete-time linear systems.
CLO 3. To introduce Z-transform methods and digital controller design.
CLO 4. To develop modern state-space methods in digital control systems design.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
2. Encourage students to ask questions and investigate their own ideas helps improve their problem-solving skills as well as gain a deeper understanding of academic concepts.
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
4. Students are encouraged to do coding based projects to gain knowledge in control processing.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in multiple representations.
7. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

Fundamentals of discrete-time signals and discretization Why study digital control systems? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system. Impulse sampling, Nyquist-Shannon sampling theorem, reconstruction discrete-time signals (Ideal filter). Realizable reconstruction methods (ZOH and FOH), transfer functions of ZOH and FOH.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Module-2

Modelling of Digital Control Systems Discretization approaches: Impulse invariance, step invariance, bilinear transformation, finite-difference approximation of derivative. Starred Laplace transform, Pulse transfer function and general procedures to obtain pulse transfer function.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Module-3

Stability Analysis and Digital Controller Design Mapping between s-plane and z-plane. stability analysis of digital systems in z-plane. Transient and steady-state analysis of time response. Digital controller design using the root-locus method; digital PID controller; deadbeat controller. Realization of digital controllers: direct programming, standard programming, series programming, parallel programming ladder programming.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Module-4

State-space Analysis of Discrete-time Systems Discretization of continuous-time state-space solution and discrete time state-space model. Representation of difference equation to state-space. Canonical forms for state-space representation and similarity transformations. Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transform, Caley-Hamilton theorem, Diagonalization).	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3
Module-5	
Controller Design in State-space Concept of controllability, distinction between reachability and controllability, digital controller design using pole-placement methods (similarity transform, Ackerman's formula). Concept of observability, distinction between detectability and observability in discrete-time systems. Observer design (prediction and current observer), output feedback controller, introduction to separation principle.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

- **CO1.** Apply sampling and reconstruction of analog signals.
- **CO2.** Obtain discrete-time models of physical systems.
- **CO3.** Evaluate the stability of digital control systems in time and frequency domain.
- **CO4.** Design performance specification based digital controller for a given system.
- **CO5.** Analyse the digital control systems using state-space methods and design digital state feedback controllers.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

22. First test at the end of 5th week of the semester
23. Second test at the end of the 10th week of the semester
24. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

25. First assignment at the end of 4th week of the semester
26. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

27. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.
Suggested Learning Resources: **Text Books:** 1. Katsuhiko Ogata, "Discrete-time Control Systems", Pearson Education. 2. M Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 4th edition, 2012. Reference Books: 1. Gene Franklin, J David Powell, Michael Workman, "Digital Control of Dynamic Systems", Addison Wesley, 3rd edition. 2. B C Kuo, "Digital Control Systems", Oxford University Press, 2nd edition.
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Simulink models for Digital Controller realization.

Artificial Intelligence for Mechatronics			
Course Code	**21MT733**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives This course will enable the students to

CLO 1. Understand the basic ideas and techniques in the design of intelligent systems.
CLO 2. Explore the advanced representation formalism and search techniques.
CLO 3. Deal with uncertain and incomplete information.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

25. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
26. Show Video/animation films to explain the functioning of various techniques.
27. Encourage collaborative (Group) Learning in the class
28. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
29. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
30. Topics will be introduced in multiple representations.
31. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
32. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to Artificial Intelligence Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI. AI applications in Mechanical and Industrial Engineering.

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Module-2

Intelligent Agents Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent. Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems.

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Module-3

Problem solving Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Genetic algorithms. Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning.

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Module-4

Knowledge and Reasoning Knowledge based Agents, Brief Overview of propositional logic, First

Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining. Knowledge Engineering in First-Order Logic, Unification, Resolution Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network.	
Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3
Module-5	
Planning and Learning The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to statistical learning (Introduction only) Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning.	
Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

- **CO1.** Develop a basic understanding of AI building blocks presented in intelligent agents.
- **CO2.** Choose an appropriate problem solving method and knowledge representation technique.
- **CO3.** Analyze the strength and weaknesses of AI approaches to knowledge–intensive problem solving.
- **CO4.** Design models for reasoning with uncertainty and unreliable information.
- **CO5.** Design and develop AI applications in real world scenarios

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

28. First test at the end of 5th week of the semester
29. Second test at the end of the 10th week of the semester
30. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

31. First assignment at the end of 4th week of the semester
32. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

33. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

8. The question paper will have ten questions. Each question is set for 20 marks.
9. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.
2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011
3. George F Luger, "Artificial Intelligence", Low Price Edition, Fourth edition, Pearson Education,2005

Reference Books:

1. Nils J Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication.
3. Patrick H Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4. Elaine Rich and Kevin Knight, Artificial Intelligence, Third Edition, McGraw Hill Education, 2017

CONTROL SYSTEMS AND ENGINEERING			
Course Code	**21MT734**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

CLO1. Students will gain the knowledge on the concept of time response and frequency response of the control system.

CLO2. Students will able to explain different control system stability techniques.

CLO3. Students will able to apply root locus technique, bodeplot to determine stability of the control system

CLO4. Students will able to apply polar plot to techniques to determine stability of the control system.

CLO5. Students will know the concept of state variables and state model.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

33. ShowVideo/animationfilmstoexplainthefunctioningofvariousfunctions.
34. Encouragecollaborative(Group)Learningintheclass
35. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking

Module-1 **8 HOURS**

Time Response of control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Module-2 **8 HOURS**

Frequency domain Analysis: Introduction to frequency domain analysis, Correlation between time & frequency response.

Concepts of stability: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Module-3 **8 HOURS**

The Root Locus Technique: Introduction toRoot locus concepts. Construction of root loci. Stability analysis using Root locus technique .Numerical problems on all topics.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Module-4 **8 HOURS**

Frequency Domain Analysis: frequency domain specifications, polar plot, The Nyquist criterion. Construction of Bode plots and Stability analysis using Bode plots.

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Module-5	8 HOURS
State space Analysis: Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Solution of problems.

Course outcome (Course Skill Set)

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

CO1. Discuss Time and frequency domain analysis of the control systems

CO2. Discuss the concept of state variables and state model

CO3. Apply the RH criterion techniques and root locus techniques to solve the stability of the control systems

CO4. Analyze the stability of the systems using Bode Plots, Polar and Nyquist plot.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. "Control Systems Engineering", I.J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.2.
2. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.

Recommended Reference Materials

1. “Automatic Control Systems”, Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
2. “Feedback and Control System”, Joseph J Distefano III et al., Schaum’s Outlines, TMH, 2nd Edition 2007

Additive Manufacturing

VLSI			
Course Code	**21MT741**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

CLO 1. Understand the fundamental aspects of circuits in silicon.
CLO 2. Relate to VLSI design processes and design rules.
CLO 3. Design and determine the electrical parameters of different CMOS logic styles.
CLO 4. Understand the design of memory array.
CLO 5. Understand the concept of VLSI testing.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

36. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
37. Show Video/animation films to explain the functioning of various techniques.
38. Encourage collaborative (Group) Learning in the class
39. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
40. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
41. Topics will be introduced in multiple representations.
42. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
43. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

An Introduction to MOS Technology: Introduction, IC era, Basic MOS transistor, nMOS fabrication, CMOS fabrication: n-well, pwell processes, BiCMOS, Comparison of bipolar and CMOS. (1.1 to 1.11)

Basic Electrical Properties of MOS And BiCMOS Circuits: Drain to source current versus voltage characteristics, threshold voltage, transconductance. (2.1 to 2.3)

Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos, Videos on transistor working, fabrication process Self-study topics: Advanced VLSI process techniques. **RBT Level:** L1, L2, L3

Module-2

Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull down ratio: nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter. (2.6 to 2.10)

MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style Design rules and layout & Scaling of MOS Circuits: λ - based design rules. (3.1 to 3.3)

Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos on latch-up Self-study topics: Layouts of complex design using Euler's method **RBT Level:** L1, L2, L3

Module-3

Basic Circuit Concepts: Sheet resistance, area capacitance calculation, Delay unit, inverter delay,

estimation of CMOS inverter delay, super buffers, BiCMOS drivers. (4.1 to 4.8) Scaling factors for device parameters (5.1 to 5.2)	
Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos on Standard cell memory Design Self-study topics: Problems on calculating sheet resistance and capacitance for CMOS circuits **RBT Level:** L1, L2, L3
Module-4	
Subsystem Design and Layout-1: Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, Examples of structured design: Parity generator, Bus arbitration, multiplexers, logic function block, code converter (6.1 to 6.4)	
Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos, Videos on working of transistor and various logic blocks Self-study topics: Design and Layout of various structured design **RBT Level:** L1, L2, L3
Module-5	
Memory, Registers and Aspects of system timing: System timing considerations, commonly used memory elements (9.1 to 9.2) **Practical aspects and testability**: Aspects of design tools, Test and testability. (10.12, 10.13 (10.13.1 to 10.13.6))	
Teaching-Learning Process	Chalk and talk method, Power point presentation, YouTube videos Self-study topics: Various Testing techniques **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

CO10. Have a basic understanding of MOS device.

CO11. Identify the CMOS layout levels, and the design layers used in the process sequence.

CO12. Determine the electrical properties of MOS circuits.

CO13. Demonstrate different logic styles such as complementary CMOS logic, pass-transistor Logic, dynamic logic, etc.

CO14. Design memory and interpret the need for testability and testing methods in VLSI.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

34. First test at the end of 5th week of the semester
35. Second test at the end of the 10th week of the semester
36. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

37. First assignment at the end of 4th week of the semester
38. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

39. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the

methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

10. The question paper will have ten questions. Each question is set for 20 marks.
11. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Book:

"Basic VLSI Design", Douglas A Pucknell, Kamran Eshraghian, 3rd Edition, Prentice Hall of India publication, 2005.

Reference Book:

1. "CMOS Digital Integrated Circuits, Analysis And Design", Sung – Mo (Steve) Kang, Yusuf Leblebici, Tata McGraw Hill, 3rd Edition, 2003.
2. "VLSI Technology", S M Sze, 2nd edition, Tata McGraw Hill, 2003.

Web links and Video Lectures (e-Resources):

•https://www.youtube.com/watch?v=oL8SKNxEaHs&list=PLLy_2iUCG87Bdulp9brz9AcvW_TnFCUmM
•https://www.youtube.com/watch?v=lRpt1fCHd8Y&list=PLCmoXVuSEVHlEJi3SwdyJ4EICffuyqpjk
•https://www.youtube.com/watch?v=yLqLD8Y4-Qc

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

- Model displayed for clear understanding of fabrication process of MOS transistor
- Practise session can be held to understand the significance of various layers in MOS process, with the help of coloured layouts
- Design an op-amp with given specification* using given differential amplifier Common source and Common Drain amplifier in library** and completing the design flow mentioned below:
  a. Draw the schematic and verify the following
  i) DC Analysis
  ii) AC Analysis
  iii) Transient Analysis
  b. Draw the Layout and verify the DRC, ERC
  c. Check for LVS
  d. Extract RC and back annotate the same and verify the Design.
  **Wherever necessary Cadence/Synopsis/Menta Graphics tools can be used.

PLCM

MECHATRONICS SYSTEM DESIGN			
Course Code	**21MT743**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:
CLO 1. Gain knowledge of basics of Mechatronics system design and sensors.
CLO 2. Understanding various techniques of Mechatronics system design for solving engineering problems.
CLO 3. Understanding Dynamic responses of systems and Fault detection techniques
CLO 4. Determination of optimization solutions, effective decision making, Convert the data in real time interfacing.
CLO 5. Understand real time mechatronic system design through case study

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1 **8 HOURS**

Introduction to mechatronics System Design: Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics.
Sensors in Mechatronics: sensors for motion and position measurement. Force and pressure sensors. Sensors for temperature measurements.

Teaching-Learning Process	9. PowerPoint Presentation, 10. Video demonstration or Simulations, 11. Chalk and Talk are used for Problem Solving (In-general). 12. Laboratory Demonstrations and Practical Experiments

Module-2 **8 HOURS**

Modeling and Simulation of Physical Elements: Operator notation and transfer functions, Block diagrams, manipulations and simulation, block diagram modeling- Direct method and analogy approach, Electrical systems, Mechanical systems**(Rotational and Translational),** electrical Mechanical Coupling, Fluid systems

Teaching-Learning Process	5. . PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Module-3 **8 HOURS**

Dynamic responses of systems and Fault Finding. Modelling of dynamic systems, Terminology, first order systems and second order systems. Fault detection techniques, Parity and error coding checks, Common hardware faults. Microprocessor systems. Emulation and simulation**.**

Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general).

	8. Laboratory Demonstrations and Practical Experiments

Module-4

8 HOURS

Signal Conditioning and Real time Interfacing: Introduction, elements of Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for data conversion, Data conversion process, Application software.

Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Module-5

8 HOURS

Case Studies: Comprehensive and Data acquisition case studies, data acquisition and control case studies.

Teaching-Learning Process	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving (In-general). 8. Laboratory Demonstrations and Practical Experiments

Course outcome (Course Skill Set)

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

CO1. Discuss about Mechatronics design process and select the sensor and Actuator for a Mechatronics application

CO2. Explain Modeling and Simulation of mechanical Elements, electrical Elements and fluid system the sensors in mechatronics systems and Fault detection techniques in Mechatronics.

CO3. Understand the elements of Data Acquisition and Control System, Convert the data in real time interfacing

CO4. Model the dynamic response of first order and second order systems.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

4. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing Company, Vikas publishing house, 2001.
5. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
6. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

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

- Quiz
- Presentations
- Group Activity

COMPUTER INTEGRATED MANUFACTURING			
Course Code	**21MT744**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course objectives:

CLO1. To gain the basic knowledge of CIM

CLO2. To understand automated flow lines and different techniques in line balancing

CLO3. To design automated assembly systems

CLO4. To gain knowledge on Computer aided process planning

CLO5.To program CNC machining centers for simple operations

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

16. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
17. ChalkandTalkmethodforProblemSolving.
18. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
19. Adoptcollaborative(GroupLearning)Learningintheclass.
20. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1

8 HOURS

Introduction: Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work in process, WIP ratio, TIP ratio, High Volume Production Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet& Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for machining operation.

Teaching-Learning Process	14. Power-pointPresentation, 15. Videodemonstration 16. ChalkandTalkareusedforProblemSolving (In-general).

Module-2

8 HOURS

Analysis Of Automated Flow Line & Line Balancing Properties General terminology and analysis, Analysis of Transfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation with numerical problems, flow lines with more than two stages, Manual Assembly lines, Minimum Rational Work Element Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method

Teaching-Learning Process	10. Power-pointPresentation, 11. Videodemonstration 12. ChalkandTalkareusedforProblemSolving (In-general).

Module-3

8 HOURS

Automated Assembly Systems Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multi station Assembly Machine analysis of single station assembly. Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV\'s with numerical problems and application.

Teaching-Learning	7. Power-pointPresentation, 8. Videodemonstration

Process	9. ChalkandTalkareusedforProblemSolving (In-general).
Module-4 **8 HOURS**	
Computerized Manufacturing Planning System Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning.	
Teaching-Learning Process	7. Power-pointPresentation, 8. Videodemonstration 9. ChalkandTalkareusedforProblemSolving (In-general).
Module-5 **8 HOURS**	
CNC Machining Centers: Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning.	
Teaching-Learning Process	7. Power-pointPresentation, 8. Videodemonstration 9. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

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

CO 1. To have fundamental knowledge of CIM

CO 2. Tounderstand the concepts of high-volume production, flow line analysis and line balancing, automated, assembly system, computerized manufacturing planning & CNC centers.

CO 3. To analyze different types of automated assembly lines

CO 4. Todevelop CNC programs for simple machining operations

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. Computer Integrated Manufacturing, J. A. Rehg& Henry. W. Kraebber.
4. CAD CAM by Zeid, Tata McGraw Hill.

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

- Industrial visit to understand the importance of CIM in production
- Practical examples of automation and Implementation of CIM in industries
- Group discussion Advantages and Limitations of CIM technology in Industries

OR

CONCEPTS OF MECHATRONICS SYSTEM DESIGN			
Course Code	**21MT751**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:
CLO 1. Gain knowledge of basics of Mechatronics system design and sensors.
CLO 2. Understanding various techniques of Mechatronics system design for solving engineering problems.
CLO 3. Understanding Dynamic responses of systems and Fault detection techniques
CLO4. Determination of optimization solutions, effective decision making, Convert the data in real time interfacing.
CLO 5. Understand Realtime mechatronics systems design to case studies

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.
3. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
4. Adoptcollaborative(GroupLearning)Learningintheclass.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1 **8 HOURS**

Introduction to mechatronics System Design: Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-2 **8 HOURS**

Actuating Devices: Direct Current Motors, Permanent magnet stepper motor, Fluid power actuation, Fluid power design elements, Piezoelectric Actuators
Sensors in Mechatronics: sensors for motion and position measurement. Force and pressure sensors. Sensors for temperature measurements.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments

Module-3 **8 HOURS**

Modeling and Simulation of Physical Elements: Operator notation and transfer functions, Block diagrams, manipulations and simulation, block diagram modeling- Direct method and analogy approach, Electrical systems, Mechanical systems**(Rotational and Translational),** electrical Mechanical Coupling, Fluid systems

Teaching-Learning	1. PowerPoint Presentation, 2. Video demonstration or Simulations,

Process	3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments
Module-4 **8 HOURS**	
Signal Conditioning and Real time Interfacing: Introduction, elements of Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for data conversion, Data conversion process, Application software.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments
Module-5 **8 HOURS**	
Case Studies: Comprehensive and Data acquisition case studies, data acquisition and control case studies.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general). 4. Laboratory Demonstrations and Practical Experiments
Course outcome (Course Skill Set) At the end of the course the student will be able to: **CO1**. Discuss about Mechatronics design process and select the sensor and Actuator for a Mechatronics application **CO2**. Explain Modeling and Simulation of mechanical Elements, electrical Elements and fluid system the sensors in mechatronics systems and Fault detection techniques in Mechatronics. **CO3**. Explain elements of Data Acquisition and Control System, Convert the data in real time interfacing **CO4.** Model the dynamic response of first order and second order systems.	

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing Company, Vikas publishing house, 2001.
2. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
3. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

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

- Group Discussion
- Quiz

VIRTUAL INSTRUMENTATION			
Course Code	**21MT752**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100

Credits	3	Exam Hours	3

Course objectives:
CLO 1. Understand the importance of Virtual Instrumentation and its architecture
CLO 2. Identify various operation of DAQ devices used in Virtual Instrumentation and Lab View.
CLO 3. Analyze the basic programming concepts in Lab View
CLO 4. Categorize types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.
CLO 5. Examine analysis tools and applications of Virtual Instrumentation

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1

8 HOURS

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. PC based data acquisition – Typical on board DAQ card, Sampling, Sampling Theorem, sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs

Teaching-Learning Process	13. PowerPointPresentation 14. Videodemonstration 15. ChalkandTalk 16. LaboratoryDemonstrationsandPracticalExperiments

Module-2

8 HOURS

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.

Teaching-Learning Process	5. PowerPointPresentation 6. Videodemonstration 7. ChalkandTalk 8. LaboratoryDemonstrationsandPracticalExperiments

Module-3

8 HOURS

Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI, Loops (While Loop and For Loop), Structures (Case, Formula node, and sequence structures) Arrays Operations, Strings Operations, and file I/O. Examples on each.

Teaching-Learning Process	5. PowerPointPresentation 6. Videodemonstration 7. ChalkandTalk 8. LaboratoryDemonstrationsandPracticalExperiments

Module-4

8 HOURS

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.	
Teaching-Learning Process	5. PowerPointPresentation 6. Videodemonstration 7. ChalkandTalk 8. LaboratoryDemonstrationsandPracticalExperiments
Module-5	**8 HOURS**
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.	
Teaching-Learning Process	5. PowerPointPresentation 6. Videodemonstration 7. ChalkandTalk 8. LaboratoryDemonstrationsandPracticalExperiments

Course outcome (Course Skill Set)

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

CO5. Understand the structured LabVIEW programming concepts in developing Virtual Instrumentation.

CO6. Build applications employed in various debugging techniques, simulating and analysing the data and use general purpose interface bus and Serial communication Interface.

CO7. Create applications that uses plug in DAQ boards and built-in analysis functions to process the data.

CO8. Design and analyze various applications on Real time monitoring using DAQ boards

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

TEXT BOOKS:

5. "Virtual Instrumentation using LabVIEW" Jovitha Jerome, PHI publication
6. Virtual Instrumentation, LABVIEW", Sanjay Gupta, TMH,NewDelhi,2003

REFERENCE BOOKS

5. PC Interfacing for Data Acquisition and Process Control &S.Gupta and JP Gupta InstrumentSocietyofAmerica,1994
6. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

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

- Group activity
- Quiz
- Presentation

PLC AND SCADA TECHNOLOGY			
Course Code	**21MT753**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50

Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

CLO 1. Understand the basics and different types of PLC
CLO 2. Solve various logical operations using relay logic and construct equivalent ladder diagram
CLO 3. Analyse the working of counters, timers and comparators
CLO 4. Diagnosis the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.
CLO 5. Understand basic concepts of SCADA and analyse its architectures

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1 **8 HOURS**

What is a plc, technical definition of plc, what are its advantages, characteristics functions of a plc, chronological evolution of plc, types of plc, unitary plc, modular plc, small plc, medium plc, large plc, block diagram of plc: input/output (i/o) section, processor section, power supply, memory central processing unit: processor software / executive software, multi-tasking, languages, ladder language

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Module-2 **8 HOURS**

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format, introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Module-3 **8 HOURS**

PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Countdown (CTD).
Advanced instructions: Introduction: Comparison instructions, discussions on comparison instructions, "EQUAL" or "EQU" instruction, "NOT EQUAL" or "NEQ" instruction, "LESS THAN" or "LESS" instruction, "LESS THANOR EQUAL' or "LEQ" instruction, GREATER THAN" OR "GRT" instruction, "GREATER THAN OR EQUAL TO" or "GRO" instruction, "MASKED COMPARISON FOR EQUAL" or "MEQ" instruction, "LIMIT TEST" or "LIM" instruction.

Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk

	4. LaboratoryDemonstrationsandPracticalExperiments
Module-4 **8 HOURS**	
PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems. Sinking and sourcing. Discrete input module. Rectifier with filter, threshold detection, Isolation, logic section, specifications of discrete input module, types of analog input module, special input modules, analog output module, I/O modules in hazardous locations power supply requirements, power supply configuration, filters.	
Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments
Module-5 **8 HOURS**	
Introduction, definition and history of Supervisory Control and Data Acquisition typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First Generation-Monolithic, Second Generation-Distributed, Third Generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System, Chemical.	
Teaching-Learning Process	1. PowerPointPresentation 2. Videodemonstration 3. ChalkandTalk 4. LaboratoryDemonstrationsandPracticalExperiments

Course outcome (Course Skill Set)

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

CO1. Demonstrate the concepts of basic programming skills of PLC using logical instructions

CO2. Apply the architecture process involved in programmable logic controller and basic programming skills of PLC using logical instructions

CO3. Examine the various operation involved in the PLC input/output module and SCADA system

CO4. Construct the ladder diagram for PLC using logical instructions, timer and counters, Data Handling instructions and build the SCADA System for Real time industrial process.

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 40% of the maximum marks (20 marks out of 50). 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 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 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 (duration 01 hour**)

- First test at the end of 5th week of the semester
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- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

3. "PLC and Industrial application", MadhuchhandanGupts and SamarjitSen Gupta, pernram international pub. (Indian) Pvt. Ltd., 2011.
4. Ronald L Krutz, "Securing SCADA System", Wiley Publication

REFERENCE BOOKS

4. GaryDunning,"Introduction to Programmable Logic Controllers", Thomson,2nd Edition.
5. John W Webb, Ronald A Reis,"Programmable Logic Controllers: Principles and Application", PHI Learning, Newdelhi, 5 th Edition
6. Stuart A Boyer, "SCADA Supervisory Control and Data Acqusition", ISA, 4 th Revised edition

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

- Group activity
- Quiz
- Presentation

INTRODUCTION TO SMART FACTORY AND INDUSTRY 4.0			
Course Code	**21MT754**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

CLO1. Gain knowledge on Automated Manufacturing system and smart manufacturing

CLO2. Understand the importance of Manufacturing support system

CLO3. Understand the concept of smart design and manufacturing

CLO4. Understanding Internet of things in Industries

CLO 5. Concepts of online monitoring and logistics in the manufacturing systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

21. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
22. ChalkandTalkmethodforProblemSolving.
23. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
24. Adoptcollaborative(GroupLearning)Learningintheclass.
25. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1

8 HOURS

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. **Introduction to Smart Manufacturing** - Dimensions -Demand-Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);

Teaching-Learning Process	17. Power-pointPresentation, 18. Videodemonstration 19. ChalkandTalkareusedforProblemSolving (In-general).

Module-2

8 HOURS

Automated Manufacturing Systems: Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system (FMS), FMS and its planning and implementation,

Manufacturing Support System: Process Planning, Computer Aided Process Planning, Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing.

Teaching-Learning Process	13. Power-pointPresentation, 14. Videodemonstration 15. ChalkandTalkareusedforProblemSolving (In-general).

Module-3

8 HOURS

Smart Design/Fabrication: Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor Networks and Devices.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-4

8 HOURS

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Service, Cloud Computing and Industry 4.0, Data acquisition mechanisms, Data interpretation techniques and tools, Development of feedback systems.	
Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).
Module-5	**8 HOURS**
Online Predictive Modeming, Monitoring, and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities,	
Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

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

CO 1. To understand the concepts Automated manufacturing, smart Manufacturing and IOT

CO 2. To know the importance of FMS, Smart design in Manufacturing

CO 3. To apply the concepts of Internet of Things technology in Industry

CO 4. To analyze the production and logistics process in Smart factory system.

Assessment Details (both CIE and SEE)

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- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

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:

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

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

5. Michael Deng, Colin Koh, Smart Factory: Transforming Manufacturing for Industry 4.0 (Industry 4.0 in ASEAN Region Series)-ISBN-13: 979-8583886425.
6. Banken, and Alasdair Gilchrist; Industry 4.0, Apress Berkeley, CA, ISBN978-1-4842-2047-4
7. Carlos Toro, Wei Wang, and Humza Akhtar, Implementing Industry 4.0, Springer Cham, ISBN978-3-030-67269-0.
8. Erwin Rauch and Manuel Woschank, Industry 4.0 for SMEs - Smart Manufacturing and Logistics for SMEs, ISBN 978-3-03936-567-8.

Web links and Video Lectures (e-Resources):

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

- Industrial visit to gain knowledge on smart factory and Industry 4.0
- Projects involving Internet of things in industrial models

ROBOTICS FOR INDUSTRY			
Course Code	**21MT755**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

CLO 1. Have fundamental knowledge of Automation and Robots
CLO 2. Understand different power source and transmission methods in Robotics
CLO 3. Gain Knowledge on End effectors and Grippers used in Robots
CLO 4. Understand different methods used in robot programming
CLO 5. Understand the different applications of robots in Industries

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes throughPowerPointpresentationsandVideodemonstrations orSimulations.
2. ChalkandTalkmethodforProblemSolving.
3. Arrangevisitstoshowtheliveworkingmodels otherthanlaboratorytopics.
4. Adoptcollaborative(GroupLearning)Learningintheclass.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills anddevelopsthinkingskillssuchasevaluating,generalizing,andanalyzinginformation

Module-1 **8 HOURS**

Introduction to Automation and Robotics: Automation and robotics, Robotics in Science Fiction, Brief history of robotics**.** Robot anatomy, work volume, robot drive systems, control systems, robot applications,

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-2 **8 HOURS**

Power Sources and Sensors:
Hydraulic, pneumatic and electric drives. determination of HP of motor and gearing ratio, variable speed arrangements

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics, problems.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-3

8 HOURS

Manipulators, Actuators and Grippers:
Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-4

8 HOURS

Robot Programming: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods, problems.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Module-5

8 HOURS

Industrial Automation:
List basic Devices in Automated Systems. Distinguish Different Controllers Employed in Automated Systems. Identify Safety in Industrial Automation
Applications: Robot applications in Material Handling, Robots in Automatic Processing Operations, Robots in Assembly and Inspection.

Teaching-Learning Process	1. Power-pointPresentation, 2. Videodemonstration 3. ChalkandTalkareusedforProblemSolving (In-general).

Course outcome (Course Skill Set)

At the end of the course the student will be able to:
CO 1. To have fundamental knowledge of Robots and Role of robots in Industrial Automation
CO 2. To list out and differentiate the different methods of robot programming
CO 3. To illustrate the functions of different components used in Robots
CO 4. To choose robots for different industrial applications

Assessment Details (both CIE and SEE)

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Two assignments each of **10 Marks**

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Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

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Semester End Examination:

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- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. 1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.
2. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person India, 2007 2nd edition.
3. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

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

- Practical examples of automation and Implementation Robots in industries
- Group discussion Advantages and Limitations of using robots in Industries