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.

B. E. (Common to all branches)
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)
SEMESTER - III

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 objectives: The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT31 is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- 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.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

Thesearesample Strategies, which teacherscan use to accelerate the attainment of the various course outcomes.

1. Inadditionto the traditionallecture method, different types of innovative teachingmethods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

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. **(8 Hours)**

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. **(8 Hours)**

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy's root 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. **(8 Hours)**

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.

(8 Hours)

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. **(8 Hours)**

Self Study: Hanging chain problem

(RBT Levels: L1, L2 and L3)

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

- To solve ordinary differential equations using Laplace transform.
- Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books:

1. **B.S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
2. **E.Kreyszig**:"Advanced EngineeringMathematics", John Wiley&Sons,10th Ed.(Reprint),2016.

Reference Books

1. **V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal& Subodh C. Bhunia:** "Engineering Mathematics" Oxford University Press, 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, Latest ed.
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.Dassand Er.Rajnish Verma:** "Higher Engineering Mathematics" S.Chand Publication (2014).
7. **James Stewart:** "Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

Web links and Video Lectures (e-Resources):
• http://.ac.in/courses.php?disciplineID=111 • http://www.class-central.com/subject/math(MOOCs) • http://academicearth.org/ • http://www.bookstreet.in. • VTU e-Shikshana Program • VTU EDUSAT Program
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning • Quizzes • Assignments • Seminars

MANUFACTURING TECHNOLOGY (IPCC)			
Course Code	21AR32	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
** Additional One hour may be considered for instructions if required*			

Course objectives:

The course will enable the students to

CLO 1. To understand the structure, behaviour and properties of engineering materials.
CLO 2. To understand processing and types of composite materials and ceramics.
CLO 3. 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-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments

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. PowerPoint Presentation, 2. Video demonstration. 3. Chalk and Talk are used for Problem Solving. 4. Laboratory Demonstrations and Practical Experiments

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. PowerPoint Presentation, 2. Chalk and Talk are used for Problem Solving. 3. Video demonstration
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. PowerPoint Presentation, 2. Chalk and Talk. 3. Video demonstration,
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. PowerPoint Presentation, 2. Chalk and Talk 3. Video demonstration, 4. Laboratory Demonstrations and Practical Experiments

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"Kalpakjian Steuen. 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.

III SEMESTER			
ANALOG AND DIGITAL ELECTRONICS			
Course Code	21AR33	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
**** Additional One hour may be considered for instructions if required***			

Course objectives: This course will enable students to:

- To understand the basics and applications of diodes and transistors
- To understand the basics and applications of OPAMPS
- To Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine-Mc Clusky Techniques.
- To Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators.
- To Describe Latches and Flip-flops, Registers and Counters.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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. Show Video/animation films to explain the functioning of various analog and digital circuits.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
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. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Junction diode for HW and FW rectification, Clippers and Clamping circuits, Transistor biasing, Dc load line analysis, Different biasing circuits, stability factors(without derivation), Transistor switching networks.

Concept of Amplifiers : RC Coupled Amplifier (Analysis), Feedback Amplifiers: Different types of feedback amplifers(Analysis),Power Amplifiers: Concept of Power Amplifiers , Class A and Class B , Push-pull power amplifier, Oscillators: Concept, Audio and Radio Frequency Oscillators, JFET and MOSFET - Working Principle and Biasing., (Text-1)

Teaching-Learning Process	Chalk and Talk Method

Module-2

OPAMP :Dual-input Balanced output Differential amplifier, Block diagram representation of an opamp, Interpretation of datasheets (Ideal V/s) practical values, Frequency response of an OPMAP, OPAMP Configurations: inverting, Non-inverting, Differential:
OPAMP Applications: Summer, integrator, differentiator, Schmitt triggers.555 Timer Applications: Astable and Monostable Multivibrator, Active Filtes. Binary weighted Resistor D/A converter and Successive Approximation A/D converter.(Text-2)

Teaching-Learning Process	Chalk and Talk Method

Module-3

Principles of combinational logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables,Incompletely specified functions (Don't care terms) Simplifying Max term equations,Quine-McClusky techniques – 3 & 4 variables.**(Text 3 - Chapter 3)**

Teaching-Learning Process	Chalk and Talk Method
Module-4	
Analysis and design of combinational logic: Decoders, Encoders, Digital multiplexers, Adders and subtractors, Look ahead carry, Binary comparators.**(Text 3 - Chapter 4).** Programmable Logic Devices, Complex PLD, FPGA. **(Text 5 - Chapter 9, 9.6 to 9.8)**	
Teaching-Learning Process	Chalk and Talk Method
Module-5	
Flip-Flops and its Applications: Basic Bistable elements, Latches, The master-slave flip flops (pulse-triggered flip-flops): SR flip-flops, JK flip-flops, Characteristic equations, Registers, binary ripple counters, and synchronous binary counters. **(Text 4 - Chapter 6)**	
Teaching-Learning Process	Chalk and Talk Method

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	To construct and observe clipping for different configurations.
2	To construct and find bandwidth of RC coupled amplifier.
3	To construct and check oscillation frequency for RC phase shift oscillator.
4	To construct and obtain OPAMP Astable multivibrator.
5	Design and implement (i) Half Adder & Full Adder using i) basic gates. ii) NAND gates (ii) Half subtractor& Full subtractor using i) basic gates ii) NAND gates
6	Design and implement 4-bitParallelAdder/Subtractor using IC 7483.
7	Design and Implementation of 1-bit Comparator.
8	Realize 4-variable function using IC74151(8:1MUX).
9	Realize the following flip-flops using NAND Gates. JK, D Flip-Flop.
10	Realize 4 bit SISO, SIPO, PIPO using D Flip flop
11	Realize 3 bit asynchronous counter using JK flip flop
12	Realize 3 bit synchronous counter using D flip flop

Course outcome (Course Skill Set)

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

1. CO1: Analyse Diode Rectifier Circuits and transistor biasing circuits.
2. CO2: Analyse Transistor Amplifier and Oscillator circuits.
3. CO3: Explain opamp basics and Analyse OPAMP applications.
4. CO4:Explain the concept of combinational and sequential logic circuits.
5. CO5:Design the combinational logic circuits.
6. CO6:Design the sequential circuits using SR, JK, D, T flip-flops

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

1.Analog Electronic Circuits: A simplified approach by U.B. Mahadevaswamy
2.OPAMPS and Linear IC's by Ramakant Gayakwad
3. John M Yarbrough,-Digital Logic Applications and Design, Thomson Learning, 2001.
4. Donald D. Givone, —Digital Principles and Design, McGraw Hill, 2002.
5. Charles H Roth Jr., Larry L. Kinney —Fundamentals of Logic Design, Cengage Learning, 7th Edition.

Web links and Video Lectures (e-Resources):

- E-book versions are available at 'https://www.knimbus.com/' of the VTU consortium. Remote login available through respective college IDs.
- You tube videos

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

- To construct and observe clipping for different configurations.
- To construct and find bandwidth of RC coupled amplifier.
- To construct and check oscillation frequency for RC phase shift oscillator.
- To construct and obtain OPAMP Astable multivibrator.
- Design and implement (i) Half Adder & Full Adder using i) basic gates. ii) NAND gates
  (ii) Half subtractor& Full subtractor using i) basic gates ii) NAND gates
- Design and implement 4-bitParallelAdder/Subtractor using IC 7483.
- Design and Implementation of 1-bit Comparator.
- Realize 4-variable function using IC74151(8:1MUX).
- Realize the following flip-flops using NAND Gates. JK, D Flip-Flop.
- Realize 4 bit SISO, SIPO, PIPO using D Flip flop
- Realize 3 bit asynchronous counter using JK flip flop
- Realize 3 bit synchronous counter using D flip flop

MECHANICS OF SOLID AND FLUIDS			
Course Code	21AR34	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:

The course will enable the students to

CLO 1. Gain knowledge of linear elastic properties and stress strain relations.
CLO 2. Derive and solve problems on Principal stresses developed in structures.
CLO 3. 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 throughPowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt collaborative (Group Learning) Learning in the class.
4. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
5. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

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	4. Power-point Presentation. 5. Video demonstration or Simulations. 6. Chalk and Talk are used for Problem Solving. Laboratory Demonstrations and Practical Experiments.

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	5. PowerPoint Presentation, 6. Video demonstration or Simulations, 7. Chalk and Talk are used for Problem Solving. 8. Laboratory Demonstrations and Practical Experiments

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	4. PowerPoint Presentation, 5. Chalk and Talk are used for Problem Solving. 6. Video demonstration or Simulations. 7. Laboratory Demonstrations and Practical Experiments

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 Process	4. PowerPoint Presentation. 5. Chalk and Talk are used. 6. Laboratory Demonstrations.

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	5. PowerPoint Presentation, 6. Chalk and Talk are used for Problem Solving. 7. Video demonstration. 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. 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 Marks scored out of 100 shall be reduced proportionally to 50 marks

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. and Izod 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.

III SEMESTER			
ROBOTIC SYSTEMS DRAWING AND STANDARDS			
Course Code	21ARL35	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:

- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.
- To make drawings using orthographic projections and sectional views
- To impart knowledge of thread forms, fasteners, keys, joints, couplings and clutches.
- 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 4 and 5 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

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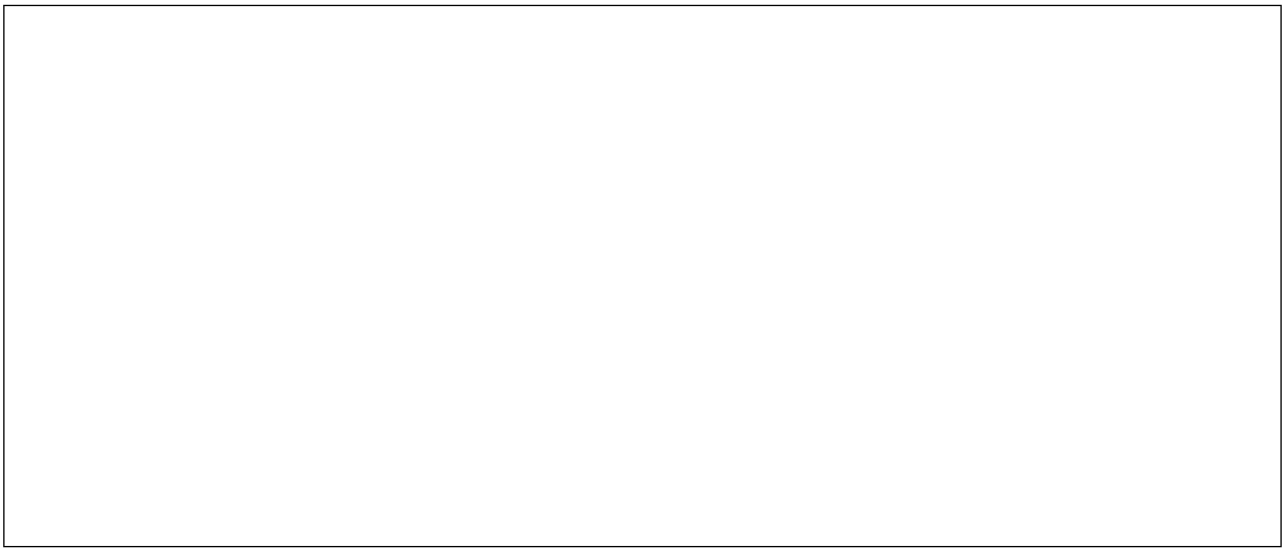

Semester 03 **Ability Enhancement Course II**

INTRODUCTION TO PYTHON			
Course Code	21AR381	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

The students will be able to:

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

Sl.NO	**Experiments**
1	Develop a python program to find the better 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:

- Demonstrate proficiency in handling of loops and creation of functions.
- Identify the methods to create and manipulate lists, tuples and dictionaries.
- Discover the commonly used operations involving regular expressions and file system.
- 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. Reema Thareja "Python Programming Using Problem Solving Approach" Oxford University Press.

Semester 03

INTRODUCTION TO VIRTUAL REALITY			
Course Code	**21AR382**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Describe how VR systems work and list the applications of VR.
- Understand the design and implementation of the hardware that enables VR systems to be built.
- Understand the system of human vision and its implication on perception and rendering.
- Explain the concepts of motion and tracking in VR systems.
- Describe the importance of interaction and audio in VR systems.

Teaching-Learning Process (General Instructions)

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

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Virtual Reality : Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output-Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3	
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
Visual Perception & Rendering : Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Motion & Tracking : Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Describe how VR systems work and list the applications of VR. CO2: Understand the design and implementation of the hardware that enables VR systems to be built. CO3: Understand the system of human vision and its implication on perception and rendering. CO4: Explain the concepts of motion and tracking in VR systems. CO5: Describe the importance of interaction and audio in VR 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**)

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:

Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

http://lavalle.pl/vr/book.html
https://nptel.ac.in/courses/106/106/106106138/
https://www.coursera.org/learn/introduction-virtual-reality.

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

- Course seminars

Semester 03

DATA STRUCTURES WITH C			
Course Code	**21AR383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:
Data structure deals with organizing large amount of data in order to reduce space complexity and time requirement. This course gives knowledge of algorithms, different types of data structures and the estimation space and time complexity.

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

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1 Introduction to Data structures

Data structures: Definition, Types. Algorithm design, Complexity, Time-Space Trade- offs. Use of pointers in data structures.Array Definition and Analysis, Representation of Linear Arrays in Memory, Traversing of Linear Arrays, Insertion And Deletion, Single Dimensional Arrays, Two Dimensional Arrays, Multidimensional Arrays, Function Associated with Arrays, Character String in C, Character String Operations, Arrays as parameters, Implementing One Dimensional Array, Sparse matrix.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 Introduction to Stacks and queue

Stack: Definition, Array representation of stacks, Operations Associated with Stacks- Push & Pop, Polish expressions, Conversion of infix to postfix, infix to prefix (and vice versa),Application of stacks recursion, polish expression and their compilation, conversion of infix expression to prefix and postfix expression, Tower of Hanoi problem.
Queue: Definition, Representation of Queues, Operations of queues- QInsert, QDelete, Priority Queues, Circular

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 Dynamic Data Structure

Linked list: Introduction to Singly linked lists: Representation of linked lists in memory, Traversing, Searching, Insertion into, Deletion from linked list, doubly linked list, circular linked list, generalized list. Applications of Linked List-Polynomial representation using linked list and basic operation. Stack and queue implementation using linked list.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 Trees and Graphs

Trees: Basic Terminology, Binary Trees and their representation, expression evaluation, Complete Binary trees, extended binary trees, Traversing binary trees, Searching, Insertion and Deletion in binary search trees, General trees, AVL trees, Threaded trees, B trees.

Graphs: Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential representation of graphs, Adjacency matrices, Transversal Connected Component and Spanning trees.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5 Sorting and Searching and file structures	
Sorting: Insertion Sort, Bubble sort, Selection sort, Quick sort, two-way Merge sort, Heap sort, Partition exchange sort, Shell sort, Sorting on different keys, External sorting. **Searching:** Linear search, Binary search, File structures: Physical storage media, File Organization, Linked organization of file, Inverted file, Organization records into blocks, Sequential blocks, Hash function, Indexing & Hashing, Multilevel indexing, Tree Index, Random file, Primary Indices, Secondary Indices, B tree index files.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Following Assignments will be provided for execution using Turbo C++:

- **Practical application of sorting and searching algorithm.**
- **Practical application of various data structure like linked list, queue, stack, tree**

Course outcome (Course Skill Set)

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

CO1: Understand basics of C programming language

CO2: Acquire knowledge of - Various types of data structures, operations and algorithms - Sorting and searching operations

CO3: Analyze the performance of - Stack, Queue, Lists, Trees, Hashing, Searching and Sorting techniques

CO4: Implement all the applications of Data structures in a high-level language

CO5: Design and apply appropriate data structures for solving computing problems

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**

4. First assignment at the end of 4th week of the semester
5. 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. Horowitz and Sahani, "Fundamentals of Data structures", Galgotia publications.
2. Tannenbaum, "Data Structures", PHI

3. R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C" PHI
4. Programming in ANSI C, Balaguruswamy, McGraw Hill Education
5. Data Structures Using C and C++ by YedidyahLangsam and Moshe J. Augenstein and Aaron M
6. Tenanbanum, 2nd Edition, Pearson Education Asia, 2002.
7. Introduction to Data Structure and Algorithms with C++ by Glenn W. Rowe

Reference Books:

1. Principles of Data Structures using C & C++ by Vinu V. Das, New Age International, 2006

Web links and Video Lectures (e-Resources):

- Data Structures - Full Course Using C and C++ https://www.youtube.com/watch?v=B31LgI4Y4DQ
- Data Structure in C | Data Structures and Algorithms | C Programming https://www.youtube.com/watch?v=11i8bRojtYk

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

- **Practical application of sorting and searching algorithm.**
- **Practical application of various data structure like linked list, queue, stack, tree**

Semester 03

SPREAD SHEETS FOR ENGINEERS			
Course Code	21AR384	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	03
** Additional One hour may be considered for instructions if required*			

Course objectives:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Sl.NO	Experiments
1	**Charting:** Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	**Functions:** Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	**Conditional Functions:** Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	**Regression Analysis:** Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	**Iterative Solutions Using Excel:** Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	**Matrix Operations Using Excel:** Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	**VBA User-Defined Functions (UDF):** The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.
8	**VBA Subroutines or Macros:** Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Exercises
9 10	**Numerical Integration Using Excel:** The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
11 12	**Differential Equations:** Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation

Course outcomes (Course Skill Set):

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

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF

- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 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:

McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

(For Mechanical Engineering & Allied branches) Choice Based Credit System (CBCS) and Outcome-Based Education (OBE) SEMESTER– IV			
COMPLEX ANALYSIS, PROBABILITY AND LINEAR PROGRAMMING			
Course Code	**21MAT41**	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:

- To provide an insight into applications of complex variables and conformal mapping arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.
- Analyze and solve linear programming models of real-life situations and learn about the applications to transportation and assignment problems.

Teaching-Learning Process (General Instructions):

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

- In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
- State the need for Mathematics with Engineering Studies and Provide real-life examples.
- Support and guide the students for self–study.
- You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
- Encourage the students for group learning to improve their creative and analytical skills.

Show short related video lectures in the following ways

- As an introduction to new topics (pre-lecture activity).
- As a revision of topics (post-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).

As a model solution for some exercises (post-lecture activity).

Module-1

Calculus of complex functions: Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences. Applications to flow problems

Construction of analytic functions: Milne-Thomson method-Problems. (**8 hours)**

Self-Study: Review of a function of a complex variable, limits, continuity, and differentiability.

(RBT Levels: L1, L2 and L3)

Pedagogy: Chalk and talk method and Powerpoint Presentations

Module-2

Conformal transformations: Introduction. Discussion of transformations $w = z^2$, $w = e^z, w = z + \frac{1}{z}, (z \neq 0)$. Bilinear transformations- Problems.

Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems. (**8 hours)**

Self-Study: Residues, Residue theorem – problems

(RBT Levels: L1, L2 and L3)

Pedagogy: Chalk and talk method and Powerpoint Presentations

Module-3
Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Mean-Variance and Standard Deviations of a random variable. Binomial, Poisson, exponential and normal distributions- problems. **(8 hours)** **Self-Study:** Two-dimensional random variables, marginals pdf's, Independent random variables **(RBT Levels: L1, L2 and L3)**
Pedagogy: Chalk and talk method and Powerpoint Presentations
Module-4
Linear Programming Problems (L.P.P): General Linear programming Problem, Canonical and standard forms of L.P.P. Basic solution, Basic feasible solution, Optimal solution, Simplex Method-Problems. Artificial variables, Big-M method, Two-Phase method-Problems. **(8 hours)** **Self-Study:** Formulation of an L.P.P and optimal solution by Graphical Method. **(RBT Levels: L1, L2 and L3)**
Pedagogy: Chalk and talk method and Powerpoint Presentations
Module-5
Transportation and Assignment Problems: Formulation of transportation problems, Methods of finding initial basic feasible solutions by North-West corner method, Least cost method, Vogel approximation method. Optimal solutions-Problems. Formulation of assignment problems, Hungarian method-Problems. **(8 hours)** **Self-Study**: Degeneracy in Transportation problem. **(RBT Levels: L1, L2 and L3)**
Pedagogy: Chalk and talk method and Powerpoint Presentations
Course outcomes: At the end of the course the student will be able to: • Use the concepts of an analytic function and complex potentials to solve the problems arising in fluid flow. • Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing. • Apply discrete and continuous probability distributions in analyzing the probability models arising in the engineering field. • Analyze and solve linear programming models of real-life situations and solve LPP by the simplex method • Learn techniques to solve Transportation and Assignment problems.
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 Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books:

- B. S. Grewal: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
- E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons,10th Ed. (Reprint),2016.
- S.D. Sharma: "Operations Research" Kedarnath Publishers Ed. 2012

Reference Books

- V. Ramana: "*Higher Engineering Mathematics*" McGraw-Hill Education,11th Ed.
- Mokhtar S.Bazaraa, John J.Jarvis & Hanif D.Sherali(2010*), Linear Programming and Network Flows(* 4th E*dition), John Wiley & sons.*
- G.Hadley (2002) *Linear Programming, Narosa Publishing House*
- F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata Mc-Graw Hill, 2010.
- Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics" Oxford University Press,3rdReprint, 2016.
- N.P Bali and Manish Goyal: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
- C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw – Hill Book Co. New York, Latest ed.
- H.K. Dass and Er. RajnishVerma:"Higher EngineeringMathematics"S.ChandPublication(2014).

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- https://www.coursera.org/learn/operations-research-modeling
- https://www.careers360.com/university/indian-institute-of-technology-madras/introduction-operations-research-certification-course
- http://people.whitman.edu/~hundledr/courses/M339.html
- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- Quizzes
- Assignments
- Seminars

IV SEMESTER			
MEASUREMENT SYSTEMS			
Course Code	**21AR42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40+13(Lab hours)	Total Marks	100
Credits	04	Exam Hours	03
**** Additional One hour may be considered for instructions if required***			

Course objectives:

This course will enable students to:

- To understand the concept of metrology and standards of measurement.
- To equip with knowledge of limits, fits, tolerances and gauging
- To understand the knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
- To understand the concept of control system.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction to Metrology: Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples.

System of Limits, Fits, Tolerance and Gauging: Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Inter changeability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design.

Pedagogy	Power point presentation along with solving numerical using chalk and board Real time examples through video

Module-2

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.

Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers.

Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

Pedagogy	Power point presentation along with solving numerical using chalk and board

Module-3	
Micro And Smart Devices And Systems: Principles And Materials: Definitions and salient features of sensors, actuators, and systems. **Sensors:** silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor. **Actuators:** silicon micro-mirror arrays, piezo-electric based inkjet print- head, electrostatic comb-drive and micromotor, magnetic micro relay, shape- memory-alloy based actuator, electro-thermal actuator. **Systems:** micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin.	
Pedagogy	Demonstrating image classification using MATLAB Power point presentation along with solving numerical using chalk and board
Module-4	
Modeling: Scaling issues. Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues. Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators.	
Pedagogy	Demonstrating Hopfield network videos Power point presentation along with solving numerical using chalk and board
Module-5	
Electronics, Circuits And Control: Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micromachined accelerometer or a thermal cycler.	
Pedagogy	Animation, Power point presentation and video demonstration of application

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Study of instruments for Liner measurement and angular measurements: Slip gauges- Measurement of angle-sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements.
2	Study of Autocollimator-Applications for measuring straightness and squareness.
3	Study of different Comparators and calibration of Dial indicator, Electrical comparators, LVDT, Pneumatic comparators
4	To Study various Temperature Measuring Instruments and to Estimate their Response times. (a) Mercury – in glass thermometer (b) Thermocouple (c) Electrical resistance thermometer (d) Bi-metallic strip
5	Various parameter measurement using computerized profile projector
6	Surface topology measurement using Surface Roughness Tester
7	Calibration of Pressure gauge, Thermocouple and Load cell
8	Circularity measurement using Electronic and Mechanical comparator
9	Demonstration of Measurement using Coordinate Measuring Machine (CMM) / Laser Scanner
10	Study of distortion factor meter and determination of the % distortion of the given oscillator.
11	Study of the following transducer (i) PT-100 transducer (ii) K –type transducer (iii) Pressure transducer
12	Characteristics of LDR, Photo-Diode, and Phototransistor
13	To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer
14	To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
	Choose any product used in the day to day life based on his/her choice, prepare a measurement plan and implement the measurement with existing tools)

Course outcome (Course Skill Set)

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

1. Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
2. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design
3. Explain measurement systems, transducers, intermediate modifying devices and terminating devices.
4. Understand basics of control system.
5. Ability to perform stability analysis of a control 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). 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:

Text Book:

- Mechanical Measurements, Beckwith Marangoni and Lienhard Pearson Education 6th Ed., 2006
- Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition

- Discrete-Time Control systems Ogata K 2nd Edition, PHI Learning Pvt. Ltd 2009.
- Digital Control Systems Kuo B.C 2nd Edition, Oxford University Press 2007
- MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc-Graw-Hill.
- "Micro and Smart Systems" by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopalakrishna,, Prof. K.N.Bhat.,John Wiley Publications.

Reference Books:

- Engineering Metrology and Measurements Bentley Pearson Education
- Theory and Design for Mechanical Measurements, III edition Richard S Figliola, Donald E Beasley WILEY India Publishers
- Animations of working principles, process flows and processing techniques, A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices.
- Laboratory hardware kits for (i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.
- Microsystems Design, S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA. ISBN 0-7923-7246-8. 2. Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6
- Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.
- MEMS- Nitaigour Premchand Mahalik, TMH 2007

Web links and Video Lectures (e-Resources):

- www.electronics-tutorials.ws
- www.electrical4u.com/electronic-ballast
- www.sciencedirect.com/topic/computer-science/sampling-theorem
- https://nptel.ac.in/content/storsge2/courses/108103008/PDF/module3/m3_lec2.pdf

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

- Visit QC section of nearby small scale industries.
- http://sl-coep.vlabs.ac.in/

IV SEMESTER			
MICROCONTROLLER			
Course Code	**21AR43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40+13(Lab hours)	Total Marks	100
Credits	04	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course Learning Objectives: This course will enable students to:

- Understand the difference between a Microprocessor and a Microcontroller and embedded microcontrollers.
- Familiarize the basic architecture of 8051 microcontroller.
- Program 8051microprocessor using Assembly Level Language and C.
- Understand the interrupt system of 8051 and the use of interrupts.
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051.
- Interface 8051 to external memory and I/O devices using its I/O ports.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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. Show Video/animation films to explain the functioning of various Micrcontrollers and digital circuits.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
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. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

8051 Microcontroller:

Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

Teaching-Learning Process	Chalk and Talk Method

Module-2

8051 Instruction Set:

Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

Teaching-Learning Process	Chalk and Talk Method

Module-3

8051 Stack, I/O Port Interfacing and Programming:

8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops.

Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

Teaching-Learning Process	Chalk and Talk Method

Module-4	
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.	
Teaching-Learning Process	Chalk and Talk Method
Module-5	
8051 Interrupts and Interfacing Applications: 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming.	
Teaching-Learning Process	Chalk and Talk Method

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	To construct and observe clipping for different configurations.
2	To construct and find bandwidth of RC coupled amplifier.
3	To construct and check oscillation frequency for RC phase shift oscillator.
4	To construct and obtain OPAMP Astable multivibrator.
5	To design and implement Simple combinational logic circuits like half adder, full adder, 2X1 MUX etc
6	Verify the working of sequential logic circuits viz flip flop, shift register.
7	Programs to generate delay, Programs using serial port and on-Chip timer/counter.
8	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal -HEX.
9	Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal.
10	Write ALPs to generate waveforms using ADC interface.
11	Write ALP to interface an LCD display and to display a message on it. 5. Write ALP to interface a
12	Stepper Motor to 8051 to rotate the motor.
13	Write ALP to interface ADC-0804 and convert an analog input connected to it.

Course outcome (Course Skill Set)

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

CO1: Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.

CO2: Write 8051 Assembly level programs using 8051 instruction set.

CO3: Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.

CO4: Write 8051 Assembly language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port and to generate an external interrupt using a switch.

CO5: Write 8051 Assembly language programs to generate square wave on 8051 I/O port pin using interrupt and C Programme to send & receive serial data using 8051 serial port.

CO6: Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

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)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. 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. "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.

2. "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.

2. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

Web links and Video Lectures (e-Resources):

- E-book versions are available at 'https://www.knimbus.com/' of the VTU consortium. Remote login available through respective college IDs.
- You tube videos

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

- To construct and observe clipping for different configurations.
- To construct and find bandwidth of RC coupled amplifier.
- To construct and check oscillation frequency for RC phase shift oscillator.
- To construct and obtain OPAMP Astable multivibrator.
- To design and implement Simple combinational logic circuits like half adder, full adder, 2X1 MUX etc
- Verify the working of sequential logic circuits viz flip flop, shift register.
- Programs to generate delay, Programs using serial port and on-Chip timer/counter.
- Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal -HEX.
- Write a C program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal.
- Write ALPs to generate waveforms using ADC interface.
- Write ALP to interface an LCD display and to display a message on it. 5. Write ALP to interface a Stepper Motor to 8051 to rotate the motor.
- Write ALP to interface ADC-0804 and convert an analog input connected to it.

IV SEMESTER			
Robot Kinetics, Dynamics & Control			
Course Code	**21AR44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:
This course will enable students to:

- To identify and enumerate different link-based mechanisms with basic understanding of motion
- To interpret and analyse various velocity and acceleration diagrams for various mechanisms
- To understand and illustrate various power transmission mechanisms using suitable method
- To design and evaluate the performance of different cams and followers

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Links and Mechanisms: Introduction: Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Grashoff's criteria. Mechanisms: Quick return motion mechanisms. Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, 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.

Pedagogy	Power point presentation along with solving numerical using chalk and board Real time examples through video

Module-2

Force principle: Alembert's principle, Inertia force, inertia torque. Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, and power transmitted, Numerical Problems.

Pedagogy	Power point presentation along with solving numerical using chalk and board

Module-3

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems.

Pedagogy	Demonstrating image classification using MATLAB Power point presentation along with solving numerical using chalk and board

Module-4	
Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power. Gyroscope: Gyroscopic couple. Effect of gyroscopic couple on plane disc, Aeroplane, Ship, stability of two wheelers and four wheelers (Without numerical problems)	
Pedagogy	Demonstrating Hopfield network videos Power point presentation along with solving numerical using chalk and board
Module-5	
Cams: Types of cams, types of followers. Displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration and Retardation, Cycloidal motion. Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, roller and flat-face follower inline and offset (Without derivations).	
Pedagogy	Animation, Power point presentation and video demonstration of application

Course outcome (Course Skill Set)

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

1. To identify and enumerate different link-based mechanisms with basic understanding of motion.
2. To understand and illustrate various power transmission mechanisms using suitable 20 methods.
3. To understand and illustrate various Governing mechanisms using suitable methods.
4. To design and evaluate the performance of different cams and followers.

Assessment Details (both CIE and SEE)

(Methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination:

Theory SEE will be conducted by University as per scheduled time table, with common question papers for subject

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

Suggested Learning Resources:

Text Book:

- Theory of Machines Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Ed 2009
- Theory of Machines Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006

Reference Books:

- Theory of Machines. Thomas Bevan. CBS Publication 1984
- Design of Machinery Robert L. Norton, McGraw Hill 2001

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112/106/112106270/

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

Visit mechanical labs to access different links and joints employed for various purposes

Robot Programming And Simulation Laboratory			
Course Code	**21ARL46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	03

**** Additional One hour may be considered for instructions if required***

Course objectives:

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations

Sl.NO	Experiments
1	Determination of maximum and minimum position of links.
2	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
3	Estimation of accuracy, repeatability and resolution.
4	Robot programming and simulation for pick and place.
5	Robot programming and simulation for Colour identification.
6	Robot programming and simulation for Shape identification.
7	Robot programming and simulation for machining (cutting, welding).
8	Robot programming and simulation for any industrial process (Packaging, Assembly).
9	Robot programming and simulation for writing practice.
10	Robot programming and simulation for multi process.
11	Robot programming and simulation for 3D printing
12	

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

- ROS (Robotic Operating System)
- 30 Systems with server
- Verification of direct kinematics equations and inverse kinematics equations of 1DOF “R- configuration” robot.
- Verification of direct kinematics equations and inverse kinematics equations of 2DOF “R-R- configuration” robot.

Course outcomes (Course Skill Set):

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

- Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots.

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:

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IV SEMESTER			
Introduction to AI & ML			
Course Code	**21AR481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

This course will enable students to:

- To impart artificial intelligence principles, techniques and its history.
- To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving engineering problems.
- To develop intelligent systems by assembling solutions to concrete computational problems

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1 Artificial Intelligence and its Issues	
Definitions - Importance of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment, Knowledge Inferring systems and Planning, Uncertainty and towards Learning Systems.	
Pedagogy	Power point presentation along with solving numerical using chalk and board Real time examples through video
Module-2 Overview to Problem Solving	
Problem solving by Search, Problem space - State space, Blind Search - Types, Performance measurement.	
Pedagogy	Power point presentation along with solving numerical using chalk and board
Module-3 Heuristic Search, Knowledge Representation and Reasoning	
Types, Game playing mini-max algorithm, Alpha-Beta Pruning. Logical systems Knowledge Based systems, Propositional Logic Constraints, Predicate Logic First Order Logic, Inference in First Order Logic, Ontological Representations and applications.	
Pedagogy	Power point presentation along with solving numerical using chalk and board
Module-4 Uncertainty and knowledge Reasoning	
Overview Definition of uncertainty, Bayes Rule Inference, Belief Network, Utility Based System, Decision Network	
Pedagogy	Power point presentation along with solving numerical using chalk and board
Module-5 Learning Systems	
Forms of Learning Types - Supervised, Unsupervised, Reinforcement Learning, Learning Decision Trees	
Pedagogy	Animation, Power point presentation and video demonstration of application

Course outcome (Course Skill Set)

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

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.
3. Demonstrate knowledge of reasoning and knowledge representation for solving realworld problems
4. Analyze and illustrate how search algorithms play vital role in problem solving
5. Illustrate the construction of learning and expert system
6. Discuss current scope and limitations of AI and societal implications

Assessment Details (both CIE and SEE)

(Methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination (SEE)

SEE paper shall be set for 50 question, each of 1 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:

Text Book:

- Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.
- Poole, D. and Mackworth, A. 2010. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press.**Reference Books:**
- Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
- Design of Machinery Robert L. Norton, McGraw Hill 2001
- Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.
- Brachman, R. and Levesque, H. 2004. Knowledge Representation and Reasoning, Morgan Kaufmann.
- Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT Press.
- Sutton R.S. and Barto, A.G. 1998. Reinforcement Learning: An Introduction, MIT Press
- Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press

Web links and Video Lectures (e-Resources):

AI And Machine Learning Full Course https://www.youtube.com/watch?v=wnqkfpCpK1g

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

Applications of MAT LAB			
Course Code	**21ARL482**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab sessions	Total Marks	100
Credits	01	Exam Hours	03
**** Additional One hour may be considered for instructions if required***			

Course objectives:

- To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
- To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
- To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration.

Sl.NO	Experiments
1	Introduction to MATLAB through matrices, and general Syntax
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB
3	Evaluating Extremum of a single variable function.
4	Understanding integration as Area under the curve
5	Evaluation of Volume by Integrals (Solids of Revolution)
6	Evaluating maxima and minima of functions of several variables
7	Applying Lagrange multiplier optimization method.
8	Evaluating Volume under surfaces.
9	Evaluating triple integrals.
10	Evaluating gradient, curl and divergence.
11	Evaluating line integrals in vectors.
12	Applying Green's theorem to real world problems.

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

- MATLAB software
- 10 Systems with server

Course outcomes (Course Skill Set):

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

- Having an ability to apply mathematics and science in engineering applications.
- Having a clear understanding of the subject related concepts and of contemporary issues.
- Having problem solving ability- solving social issues and engineering problems.

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:

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Applications of Raspberry Pi Controllers			
Course Code	**21ARL483**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	12 Lab Sessions	Total Marks	100
Credits	01	Exam Hours	03
**** Additional One hour may be considered for instructions if required***			

Course objectives:

- To understand and use Raspberry Pi controllers.

Sl.NO	Experiments
1	Creating the sensor project.
2	Creating the actuator project.
3	Creating a controller.
4	Creating a camera.
5	To study the architecture of SOC Broadcom-2835 application board of Raspberry Pi.
6	To demonstration the OS (Debian) for RPi in a SD card preparation, configuration of Raspberry Pi during first booting and use of remote SSH like putty
7	To demonstrate the basic linux commands on Raspberry pi.
8	To create a database & Store the value in Raspberry Pi.
9	To install Android on Raspberry Pi.
10	To Setup RPi first time without using screen, mouse, keyboard.
11	To interface ADC at GPIOs of Raspberry Pi for measuring analog voltage.
12	

LIST OF EQUIPMENTS BATCH OF 30 STUDENTS:

- Raspberry Pi controller Kits - 10 numbers
- 10 Systems with server

All related components with respect to the experiments.

Course outcomes (Course Skill Set):

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

- Apply Raspberry Pi controller in different fields.

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:

IV Semester

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT			
Course Code	**21UHV49**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	20	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

This introductory course input is intended:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

This course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Teaching-Learning Process (General Instructions)

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

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. The course is in the form of 20 lectures (discussions)
3. It is free from any dogma or value prescriptions.
4. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation
   – the whole existence is the lab and every activity is a source of reflection.
5. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
6. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

Module-1

Introduction to Value Education (4 hours)

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

Teaching-Learning Process	Introduction to Value Education- Chalk and talk method, Discussion, Sharing of experiences, Live Examples and videos

Module-2	
Harmony in the Human Being (4 hours) Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health	
Teaching-Learning Process	Introduction to the concepts- Chalk and talk method, Discussion, Sharing of experiences, Live Examples and videos
Module-3	
Harmony in the Family and Society (4 hours) Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order	
Teaching-Learning Process	Introduction to the concepts- Chalk and talk method, Discussion, Sharing of experiences, Live Examples and videos
Module-4	
Harmony in the Nature/Existence (4 hours) Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence	
Teaching-Learning Process	Introduction to the concepts- Chalk and talk method, Discussion, Sharing of experiences, Live Examples and videos
Module-5	
Implications of the Holistic Understanding – a Look at Professional Ethics (4 hours) Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession	
Teaching-Learning Process	Introduction to the concepts- Chalk and talk method, Discussion, Sharing of experiences, Live Examples and videos

Course outcome (Course Skill Set)

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct

5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

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

Continuous Internal Evaluation:

Three Unit Tests 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

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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 01 hours).** Question paper will contain 50 question each of one marks. Pattern of the question paper is MCQ. The students have to answer all the questions

Suggested Learning Resources:

Books

-READINGS:

Text Book and Teachers Manual

a. The Textbook

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher‟s Manual

Teachers‟ Manual for *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G

Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

1. Value Education websites, https://www.uhv.org.in/uhv-ii, http://uhv.ac.in, http://www.uptu.ac.in
2. **Story of Stuff, http://www.storyofstuff.com**
3. **Al Gore, An Inconvenient Truth, Paramount Classics, USA**
4. **Charlie Chaplin, Modern Times, United Artists, USA**
5. **IIT Delhi, Modern Technology – the Untold Story**
6. Gandhi A., Right Here Right Now, Cyclewala Productions
7. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
8. https://fdp-si.aicte-india.org/8dayUHV_download.php
9. https://www.youtube.com/watch?v=8ovkLRYXIjE
10. https://www.youtube.com/watch?v=0gdNx0X923I
11. https://www.youtube.com/watch?v=nGRcbRpvGoU
12. https://www.youtube.com/watch?v=sDxGXOgYEKM

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

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V SEMESTER			
DESIGN OF AUTOMATION SYSTEM			
Course Code	21AR51	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:

- To know about the basic concepts in industrial automation
- To design automated systems.
- To know about transfer lines and automated assembly
- Be exposed to pneumatic, electric, hydraulic and electronic systems in automation of mechanical operations.
- To know about the advancement in hydraulics and pneumatics

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. Adopt flipped classroom teaching method.
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

FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

TRANSFER LINES AND AUTOMATED ASSEMBLY

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.

Module-3

DESIGN OF MECHATRONIC SYSTEMS

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.

Module-4	
PROGRAMMABLE AUTOMATION Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.
Module-5	
DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. 4. Arrange Industrial visit to a power plant.

Course Outcomes (Course Skill Set)

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

1. Knowledge of industrial automation by transfer lines and automated assembly lines.
2. Ability to design an automated system
3. Understanding of automated controls using pneumatic and hydraulic systems
4. Ability to understand the electronic control systems in metal machining and other manufacturing processes.
5. To understand advancement in hydraulics and pneumatics 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). 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**)

13. First test at the end of 5th week of the semester
14. Second test at the end of the 10th week of the semester
15. 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

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

1. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books Books

1. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2001.
2. Bolton W, "Mechatronics", Pearson Education, 1999.

Reference Books

1. 1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.
2. 2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011.

Web links and Video Lectures (e-Resources):

- https://www.mathworks.com/videos/model-based-design-for-automation-systems-81820.html
- https://nptel.ac.in/courses/112104288
- https://archive.nptel.ac.in/courses/108/105/108105062/

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

- Visit nearby industries undergoing automated production lines, assembly lines etc.
- Have a brief introduction of SAP system.

V SEMESTER			
Hydraulics and Pneumatics			
Course Code	**21AR52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
*** One additional hour may be considered wherever required**			

Course objectives:

- **To provide an insight into the capabilities of hydraulic and pneumatic fluid power.**
- **To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.**
- **To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and**
- **control components in fluid power systems.**
- **Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.**
- **To familiarize with logic controls and trouble shooting**

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 traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

MODULE-1 **8 HOURS**

Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

Teaching-Learning Process	Understanding, Remembering Chalk & Talk Method / Power point presentation/ You tube videos

MODULE-2	**8HOURS**
Pumps and actuators **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 factors, problems on pumps. Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor. **Actuators:**Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power,flowrate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).	
Teaching-Learning Process	Understanding, Remembering Chalk & Talk Method / Power point presentation/ You tube videos
MODULE-3	**8 HOURS**
Components and hydraulic circuit design **Components:**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, and check valves. Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. **Hydraulic Circuit Design:**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, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits.Pilot pressure operated circuits.Hydraulic circuit examples with accumulator.	
Teaching-Learning Process	Understanding, Remembering Chalk & Talk Method / Power point presentation/ You tube videos
MODULE-4	**8 HOURS**
Pneumatic power systems Introduction to Pneumatic systems:Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit. Pneumatic Actuators: Linear cylinder –types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. 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.	
Teaching-Learning Process	Understanding, Remembering Chalk & Talk Method / Power point presentation/ You tube videos
MODULE 5	**8 HOURS**
Pneumatic control circuits **Simple Pneumatic Control:** Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling. **Signal Processing Elements:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.	

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	Understanding, Remembering Chalk & Talk Method / Power point presentation/ You tube videos

PRACTICAL COMPONENT OF IPCC

Course objectives:

- Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.

Students should build up the circuits on computer using software and simulate the flow of fluid during the operation. Afterwards, they themselves can physically connect the circuit on the hydraulic/pneumatic trainer and run the circuit.

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 outcome (Course Skill Set)

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

CO1: Identify and analyse the functional requirements of a fluid power transmission system for a given application.
CO2: Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.
CO3: Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro- pneumatics for a given application.
CO4: Select and size the different components of the circuit.
CO5: Develop a comprehensive circuit diagram by integrating the components selected for the given 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). 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)

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.
12. 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. Anthony Esposito, "Fluid Power with applications", Pearson edition,2000 .
2. Majumdar S.R., "Oil Hydraulics",TalaMcGRawHllL, 2002 .
3. Majumdar S.R., "Pneumatic systems - Principles and Maintenance",Tata McGraw-Hill, New Delhi, 2005

REFERENCE

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics,VolI,IIandIII.

4. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, PrentcieHall, 2004
6. John Watton, “Fundamentals of fluid power control”, Cambridge University press, 2012.

Web links and Video Lectures (e-Resources):

- **https://archive.nptel.ac.in/courses/112/101/112101099/**
- **https://archive.nptel.ac.in/content/storage2/courses/112106175/Module%201/Lecture%201.pdf**
- **https://www.digimat.in/nptel/courses/video/112101099/L02.html**

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

- **Visit nearby service stations to study about applications of hydraulics and pneumatic systems.**
- **Visit nearby Earth movers and automobiles assembly plants.**

AUTONOMOUS ROBOTS			
Course Code	21AR53	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:

- To learn principles of working of autonomous robots
- To learn the holistic design of autonomous robots - from the mechatronic design to sensors and intelligence.
- To demonstrate the sensing, perception, and cognition of autonomous robots
- To understand anatomy of autonomous robots
- To understand operation of Humanoid robot
- To understand principles of operation of telecheric robots

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. Adopt flipped classroom teaching method.
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

The Basics of Autonomy (Motion, Vision and PID)

Programming Complex Behaviours (reactive, deliberative, FSM), Robot Navigation (path planning), Robot Navigation (localization), Robot Navigation (mapping), Embedded electronics, kinematics, sensing, perception, and cognition.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

PROPULSION AND ROBOT LOCOMOTION

Frame Rotations and Representations– Propulsion systems and actuation– Robot System Dynamics

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.

Module-3

Perception and State Estimation

Inertial Sensors and GPS– Camera Sensors– LiDAR– Furthe Sensing Modalities– State Estimation Theory– The Kalman Filter– Simultaneous Localization And Mapping

Flight Controls

PID Control– LQR Control– Linear Model Predictive Control– An Autopilot Solution

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.

Module-4

Guidance and Control

Introduction to Control Theory– Feedback Control Fundamentals– PID, LQR and MPC laws– Guidance laws for nonholonomic systems

Path Planning

Holonomic Vehicle Boundary Value Solver– Dubins Airplane model Boundary Value Solver– Collision-free Navigation– Structural Inspection Path Planning– Autonomous Exploration

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving.

Module-5

Robot Remote Control

Robot Remote Control– Graphical User Interface design– Augmented Reality–assisted robot control

Telecheric robots

Concepts of teleoperations, Need and applications of Telecheric robots, Humanoid Robots, Swarm Robotics, Robot Applications and Ethics.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. 4.The students will be organized into teams and each team will design a robot in order to address a specific application and challenge. The final challenges will be derived based on real-requirements of federal agencies or needs of specific industries.

Course Outcomes (Course Skill Set)

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

1. Demonstrate the sensing, perception, and cognition of autonomous robots
2. Understand anatomy of autonomous robots
3. Understand operation of Humanoid robot
4. Understand principles of operation of telecheric robots

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

Continuous Internal Evaluation:

Three Unit Tests 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**

3. First assignment at the end of 4th week of the semester
4. 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**)

5. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books Books

1. Autonomous Mobile Robots by Roland Siegwart, Illah Reza Nourbakhsh and Davide Scara-muzza.
2. Handbook of Robotics, second version edited by B. Siciliano, O. Khatib.

Reference Books

1. Designing Autonomous Mobile Robots, John M Holland, Elsevier, 2004
2. Morgan Quigley , Brian Gerkey, Programming Robots with ROS, Quigley et al, O'Rielly Publishers, Murphy 2000.
3. Autonomous Mobile Robots, Edited by Shuzhi Sam Ge, Frank L Lewis, Taylor and Francis, 2006
4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", MIT Press, 2nd Edition, 2011.
5. Peter Corke, Robotics Vision and Control, Springer 2011.
6. Thomas Braunl, "Embedded Robotics", Second Edition, Springer, 2006.
7. WitoldJacak, "Intelligent Robotic Systems: Design Planning and Control", Kluwer Academic Publishers, 1999.

Web links and Video Lectures (e-Resources):

- http://www.kostasalexis.com/autonomous-mobile-robot-design.html

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

The students will be organized into teams and each team will design a robot in order to address a specific application and challenge. The final challenges will be derived based on real-requirements of federal agencies or needs of specific industries.

V SEMESTER			
ROBOT OPERATING SYSTEM			
Course Code	**21AR54**	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:

Students will be able

- Discuss the fundamental concepts of Operating Systems.
- Explain the mechanisms of Operating Systems to handle processes, threads and their communication.
- Analyze the file structure and the protection and secuRIty mechanism.
- Explain the Memory management technique to improve the CPU utilization and its response speed.

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. Adopt flipped classroom teaching method.
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 INTRODUCTION TO OPERATING SYSTEMS	**8 HOURS**
Basic PRInciples, Operating System Structures, System Calls & Types, Processes: Concept – Scheduling - Inter Process Communication, Introduction to DistRIbuted Operating System, Types of network based OS.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2 OVERVIEW OF RTOS	**8 HOURS**
RTOS Task and Task State, Preemptive Scheduler, Process Synchronization, Message Queues, Mailboxes, Pipes, CRItical Section, Semaphores, Classical Synchronization Problem –Deadlocks.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3 BOARD SUPPORT PACKAGES	**8 HOURS**
Inserting BSP in Kernel Build Procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem: Timers - UART- Power Management. Embedded Storage: MTD – MTD Architecture - MTD DRIver for NOR Flash - Flash Mapping DRIver	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4 EMBEDDED KERNEL & COMPONENTS	**8 HOURS**
Embedded File System: RAMDisk – RAMFS – CRAMFS, Journaling Flash File Systems: JFFS and JFSS2, NFS: PROC File system, Optimizing storage Space: Kernel space optimization - Application Space Optimization, Applications for Embedded Linux - Tuning kernel memory.	

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE- 5 Linux Devices DRIvers 8 HOURS

Embedded DRIvers: Linux SeRIal DRIver - Ethernet DRIver - I 2C Subsystem on Linux - USB Gadgets, Watchdog Timer, Kernel Modules.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Discuss the basic concepts of operating system and distRIbuted system
- Explain RTOS task scheduling, task synchronization and task communication mechanisms.
- Install Linux for specified configuration, develop Linux C programs and implement Linux file 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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

Text Books:

1. Silberschatz, Galvin, Gagne, "Operating System Concepts", 6th edition, John Wiley, 2003.
2. Raj Kamal, "Embedded Systems -Architecture, Programming and Design", Tata McGraw Hill, 2006.
3 P. Raghavan, Amol Lad, SRIram Neelakandan, "Embedded Linux System Design and development", Auerbach Publications 2005.
4 Jonathan Corbet, Allesandro Rubini & Greg Kroah-Hartman, "Linux Device DRIvers", O'Reilly, 3rdedition, 2005.

Reference Books:

1. https://www.youtube.com/watch?v=PEzpOembKNc
2. https://www.youtube.com/watch?v=mCs21yByQqk
3. https://www.youtube.com/watch?v=hDn4hM148V8

Web links and Video Lectures (e-Resources):

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

V SEMESTER			
VIRTUAL INSTRUMENTATION AND AUTOMATION LAB			
Course Code	**21ARL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

Students will be able to

- Understanding Virtual Instrument concepts and data acquisition operation
- Creating Virtual Instruments for practical works

Sl.NO	Experiments
1	Creating Virtual Instrumentation for simple applications- Invert The State Of Boolean Indicator Twice A See Until Program Is Stopped By User.
2	Programming exercises for loops in virtual instrumentation-Continuous Monitoring of Temperature (Generated using Random no 0<t
3	Programming exercises for graphs- Display Random Number Into 3 different CHARTS (STRIP, SLOPE,SWEEP) and understand the difference between these in the UI. 4
4	Programming Exercises on case and sequence structures:-Design the simple Calculator, making use of the inherent GUI present in the virtual instrumentation software.
5	Programming Exercises on Arrays– Take a 2D array input from the user and perform various array(and matrix) manipulations on it
6	6. Programming Exercises on File Input output System – Read and write from ASCII and TDMS files.
7	Real time temperature acquisition and continuous monitoring using Virtual Instrumentation
8	Developing voltmeter using DAQ cards – Acquiring a voltage and displaying it on a 'meter' indicator on the UI, thus designing a voltmeter
9	Developing Signal Generator using DAQ Card – Using analog output; amplitude, shape and frequency controlled by user
10	Data acquisition through Virtual Instrumentation – Read voltage and current of the 50 Hz supply to compute power and power factor
11	Design and Development of Filter Analysis using DAQ card – Acquire audio and filter out bands using different filters and compare effects
12	Real time sequential control of any batch process – Water level control or Temperature control

Course outcomes (Course Skill Set):

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

- Understand, design and develop data acquisition systems for Various Sensor using DAQ Cards.
- Analyze the importance & applications of LabVIEW in real time 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 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:

- https://www.youtube.com/watch?v=ZHNlKyYzrPE
- https://www.ni.com/pdf/manuals/373427j.pdf

etc....

V SEMESTER			
MEDICAL ROBOTICS			
Course Code	**21AR581**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1-0-0-0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Provide knowledge on the application of robotics in the field of health care
- Overview of the sensor requirements for localization and tracking in medical applications
- Understand the design aspects of medical robots

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. Adopt flipped classroom teaching method.
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	**3 HOURS**
Introduction : Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2	**3 HOURS**
Localization And Tracking : Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - HybRId systems.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3	**3 HOURS**
Control Modes : Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4	**3 HOURS**
Rehabilitation : Rehabilitation for Limbs - Brin-Machine Interfaces - Steerable Needles – case studies. **Robots In Medical Care:** Assistive robots –types of assistive robots – case studies	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5	**3 HOURS**
Design of Medical Robots : Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Discuss about the sensors used for localization and tracking
- Summarize the applications of surgical robotics
- Outline the concepts in Rehabilitation of limbs and brin machine interface
- Classify the types of assistive robots.
- Analyze the design charactristics, methodology and technological choices for medical robots.

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**

4. First assignment at the end of 4th week of the semester
3. 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. Medical robotics- Minimally Invasive surgery Paula Gomes Woodhead, 2012

Reference

2. Daniel Faust Medical Robots Rosen Publishers 2016

Web links and Video Lectures (e-Resources):

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

V SEMESTER			
Deep Learning for Computer Vision			
Course Code	**21AR582**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

- Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.
- Become familiar with neural networks
- This topics course aims to present the mathematical, statistical and computational
- challenges of building stable representations for high-dimensional data
- Discussing recent models from supervised learning
- Discussing recent models from unsupervised learning

List of Tutorials:

1. Shallow Neural Networks
2. Key concepts on Deep Neural Networks
3. Practical aspects of deep learning ,Optimization Algorithms
4. Hyperparameter tuning, Batch Normalization, Programming Frameworks
5.Bird recognition in the city of Peacetopia (case study)
6. Autonomous driving (case study)
7. The basics of ConvNets
8. Deep convolutional models
9. Keras Tutorial
10. Detection Algorithms
11. Special Applications: Face Recognition & Neural Style Transfer

Sl.NO	Experiments
1	Planar data classification with a hidden layer
2	Building your Deep Neural Network: step by step
3	Deep Neural Network – Application
4	Initialization, Regularization, Gradient Checking, Optimization
5	Tensorflow
6	Convolutional Model: step by step, application
7	Residual Networks
8	Car Detection with YOLO
9	Art Generation with Neural Style Transfer
10	Face Recognition

Course outcomes (Course Skill Set):

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

- 1. Develop intelligent software to automate routine labor, understand speech or images, make
- diagnoses in medicine and support basic scientific research
- 2. Solving the tasks that are easy for people to perform but hard for people to describe
- formally.
- 3. Apply deep learning models for retrieval of information and machine translation.
- 4. Develop an artificial Intelligence system for the deep neural network-based applications.
- 5. Evaluation of various algorithms using deep learning.
- 6. Design of intelligent model using algorithms of deep learning

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:

- https://www.youtube.com/watch?v=ZHNlKyYzrPE
- https://www.ni.com/pdf/manuals/373427j.pdf

etc....

V SEMESTER			
MOBILE ROBOTICS			
Course Code	**21AR583**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1-0-0-0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Provide knowledge on the application of mobile robotics

Teaching-Learning Process (General Instructions)

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

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1	**3 HOURS**
INTRODUCTION: Telerobotics: Overview and background – Brief history.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2	**3 HOURS**
COMMUNICATIONS AND NETWORKING: The Internet – Wired Communication Links – Wireless Links – Properties of Networked Telerobotics – Building a Networked Telerobotic system – State command Presentation – Command Execution/ State Generation – Collaborative Control	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3	**3 HOURS**
FUNDAMENTALS OF ONLINE ROBOTS: Introduction – Robot Manipulators – Teleoperation – Teleoperation on a local network – Teleoperation via a constrained link.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4	**3 HOURS**
ONLINE ROBOTS: Introduction to networked robot system on the Web – Software Architecture and design – Interface design.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5	**3 HOURS**
CASE STUDY:Performance of mobile robots controlled through the web – System Description – Software Architecture.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Understand the development and operation of mobile robotics.

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**

4. First assignment at the end of 4th week of the semester
4. 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. Bruno Siciliano, Oussama Khatib, —Springer Handbook of Robotics||, Springer Science and Business, 2010.
2. Ken Goldberg, Roland Siegwart, —Beyond Webcams – An Introduction to Online Robots||, MIT Press, 2010.

Reference

1. Borko Furht, Armando Escalante, —"Handbook of Cloud Computing", Springer Science & Business, 2010.
2. Peter Sinčák, Pitoyo Hartono, Mária Virčíková, Ján Vaščák, Rudolf Jakša , —"Emergent Trends in Robotics and Intelligent Systems", Springer, 2014.

Web links and Video Lectures (e-Resources):

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

VI Semester

Quality Control Process and Maintenance Management			
Course Code	**21AR61**	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:
To facilitate the understanding of Quality Management principles and process.
To impart knowledge in maintenance.
To know about the fundamentals of maintenance and to implement it.

Pedagogy (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.
1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby industries and production plant where SCADA is existing to understand about the working.
3. Show Video/animation films to explain functioning of various analog and digital device associated with the PLC and SCADA.
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
9. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1 INTRODUCTION	
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.	
Pedagogy	Chalk and talk, power point presentation

Module-2 TQM PRINCIPLES	
Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.	
Pedagogy	chalk and talk , power point presentation and animated videos .

Module-3 TQM TOOLS AND TECHNIQUES	
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types. Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	
Pedagogy	Chalk and talk , power point presentation

Module-4 MAINTENANCE	
Types – breakdown, preventive, predictive, TPM; elements of preventive maintenance – checklist, schedule, procedure.	
Pedagogy	Power point presentation

Module-5 TOTAL PRODUCTIVE MAINTENANCE:

Principles; preparatory stages of implementation – TPM organisation structure, creation; basic TPM policies and aids, master plan. TPM IMPLEMENTATION: Small group activities, autonomous maintenance, establishing planned maintenance, training, developing equipment management program.

Pedagogy	Power point presentation , animated videos

Course outcome (Course Skill Set)

At the end of the course the student will be able to :
CO1:The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.
CO2:Maintain the industry without any risk in its operation.
CO3:Improve the production.
CO4:Analyze the hazards in maintenance and to solve it.

Assessment Details (both CIE and SEE)

(methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination:

Theory SEE will be conducted by University as per scheduled time table, with common question papers for subject

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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Robinson C J and Ginder A P, “Implementing TPM”, Productivity Press, USA, 1995.

References:

3. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO 9001-2015 standards
5. Dhillon B S, “Maintainability, Maintenance and Reliability for Engineers”, CRC Press, 2006.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/110/101/110101150/
https://archive.nptel.ac.in/courses/110/105/110105088/
https://www.youtube.com/watch?v=f58SW0Hwcf0
https://archive.nptel.ac.in/courses/105/102/105102176/
https://www.digimat.in/nptel/courses/video/105102176/L39.html

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

VI Semester

PLC AND SCADA			
Course Code	**21AR62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40+13(LAB Sessions)	Total Marks	100
Credits	03	Exam Hours	03
** Additional One hour may be considered for instructions if required*			

Course objectives:

- To know the importance and benefits of automation and to understand how to automate an industrial process using PLC.
- To understand the instructions of PLC
- To program PLC using the Ladder diagrams.
- Be aware of applications of timers, counters and effective use of program flow control instructions to manage PLC operations.
- Appreciate the need for DCS/ SCADA in Process Control Instrumentation
- To Understand the working of HMI Automation

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby industries and production plant where SCADA is existing to understand about the working.
3. Show Video/animation films to explain functioning of various analog and digital device associated with the PLC and SCADA.
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
9. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1	
Definition of Automation, Types and applications in Industry, Basic concepts of PLC, PLC components – I/O configuration, Introduction to PLC operation, Binary data representation, Input and Output status files, sixteen point I/O modules, PLC memory Architecture of PLC:- Modular and brick type.I/O Modules: D/I, D/O, A/I, A/O and communication modules. PLC symbols, Advantages and Disadvantages of PLC, List PLC applications. Communication to PC and PLC through serial, MODBUS, Ethernet	
Pedagogy	Chalk and talk, power point presentation

Module-2	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-in Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. Programming Timers: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers."	
Pedagogy	chalk and talk , power point presentation and animated videos . projects using ladder logic can be given as case study

Module-3	
Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counter and timers. Program Control and Data manipulation Instructions: -Data handling instructions, Sequencer instructions, Programming sequence output instructions, Comparison and selection of Industrial PLC for automation . Introduction to Variable Frequency Drive and its applications with PLC	
Pedagogy	Chalk and talk , power point presentation
Module-4	
DCS architecture, Makes of DCS, Database organization in DCS, System elements of DCS Field station, Intermediate station, Central computer station, Reliability parameters of DCS, Classification of alarms in DCS, Comparison of DCS with PLC.	
Pedagogy	Power point presentation
Module-5	
human-Machine Interface (HMI):HMI components, HMI software functionalities, Situational awareness, Intelligent alarm filtering: Need and technique, Alarm suppression techniques, Operator needs and requirements, SCADA Systems: Building the SCADA systems, legacy, hybrid, and new systems, Classification of SCADA systems, SCADA implementation: A laboratory model: The SCADA laboratory, System hardware, System software, SCADA lab field design. Basics of HMI, Applications of HMI, Developing graphics: -Temperature and Two Level control. Comparison of HMI with SCADA.Human Interface subsystem:-Operator panel, construction of Panel, Interfacing with control subsystem, types of mimic panels.	
Pedagogy	Power point presentation , animated videos for showing the working of scada

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*
Modern computing tools are preferred to be used for analysis wherever possible.

Sl.NO	Experiments	
1	Develop the logical instructions involved in Development of programmable logic controller for var operations	ous
2	Construct the Ladder Logic for various operation using PLC and SCADA for industrial Environment.	
3	Design the SCADA System for industrial Environment.	
4	Study of various logic Execution in ladder diagram.	
5	Interfacing of Lamp & button with PLC for ON&OFF Operation. Verify all logic gates.	
6	PLC based thermal ON/OFF Controller.	
7	Develop ladder logic to develop MUX and DE-MUX	
8	Combination of counter &timer for lamp ON/OFF Operation.	
9	Study& implement ON & OFF delay timer in PLC	
10	To study & implement of counter in PLC programming. counter-up & counter-down	
11	PLC based temperature sensing using RTD	
12	Parameter reading of PLC in SCADA, Temperature sensing using SCADA	

Course outcome (Course Skill Set)

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

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

CO1: Describe working of various blocks of basic industrial automation system
CO2: Connect the peripherals with the PLC
CO3: Use various PLC functions and develop small PLC programs
CO4: Summarize Distributed control system and SCADA system.
CO5: Use various industrial motor drives for the Industrial Automation.

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:

Books

1. Introduction to Programmable Logic Controllers by Garry Dunning,Thomson,2nd edition,Thomson,ISBN: 981-240-625-5
2. Practical SCADA for Industry, David Bailey and Edwin wright, Newnes An imprint of Elsevier, 2003, ISBN 07506 58053

References:

1. Programmable Logic Controllers, JR Hackworth, Frederick , Pearson Education
2. Programmable Logic Controllers, W Bolton, Elsevier

Web links and Video Lectures (e-Resources):

- https://www.onupkeep.com/answers/asset-management/plc-vs-scada
- https://www.youtube.com/watch?v=F7IKeBgP-Sw
- https://www.controlfreaksltd.co.uk/what-is-the-difference-between-plc-and-scada/
- https://www.telstarinc.com/blog/how-scada-hmi-and-plc-work-together/
- https://www.jigsawacademy.com/blogs/data-science/plc-scada
- https://www.eit.edu.au/cms/images/Webinar_Slides/03_SK_Chapter-01_r4.pdf
- http://www.eastrocontrol.com/documents/abb/AC500.pdf

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

- https://www.vlab.co.in/broad-area-electrical-engineering
- https://plc-coep.vlabs.ac.in/Introduction.html

VI Semester

Industry 4.0 and IOT			
Course Code	**21AR63**	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:

- Introduce the concept of Industry 4.0.
- Understand the basics of Internet of things and protocols.
- Introduction to some of the application areas where Internet of Things can be applied.
- To learn about the working of Internet of Things.
- To understand the concepts of Web of Things.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby industries and production plant where SCADA is existing to understand about the working.
3. Show Video/animation films to explain functioning of various analog and digital device associated with the PLC and SCADA.
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
9. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1 INDUSTRY 4.0	
Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	
Pedagogy	Chalk and talk, power point presentation
Module-2 IOT	
What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.	
Pedagogy	chalk and talk , power point presentation and animated videos .
Module-3 IOT PROTOCOLS	
Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFIDProtocols – Issues with IoT Standardization – Unified Data Standards –Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security	
Pedagogy	Chalk and talk , power point presentation
Module-4 IOT ARCHITECTURE	
IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity : An Open source IoT stack -Overview- IoTivity stack architecture- Resource model and Abstraction, IoT and Big Data. - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardizationfor WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals andBusiness Intelligence.	
Pedagogy	Power point presentation

Module-5 IOT APPLICATIONS	
IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc., Introduction to Fog Computing.	
Pedagogy	Power point presentation , animated videos for showing the working of scada

Course outcome (Course Skill Set)

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

CO1: Understand the drivers and enablers of Industry 4.0

CO2: Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services

CO3: Outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world

CO4: Appreciate the power of Cloud Computing in a networked economy

CO5: Understand the opportunities, challenges brought about by Industry 4.0 and how organisations and individuals should prepare to reap the benefits

Assessment Details (both CIE and SEE)

(methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination:

Theory SEE will be conducted by University as per scheduled time table, with common question papers for subject

3. The question paper will have ten questions. Each question is set for 20 marks.
4. 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.
5. The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

- Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
- Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet ofThings", Springer, 2011.
- David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a HighlyConnected World", Cambridge University Press, 2010.
- Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.

References:

- Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
- Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything", 1st Edition, Apress Publications, 2013
- CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN:978-1-4493-9357-1

Web links and Video Lectures (e-Resources):
● NOC:Design for internet of things, IISc Bangalore - NPTEL https://nptel.ac.in/courses/108108098 ● Introduction To Industry 4.0 And Industrial Internet Of Things https://onlinecourses.nptel.ac.in/noc22_cs52/preview ● MOOC Practical Internet of Things (IoT) 1.1 https://www.youtube.com/watch?v=LdHdVBNBAJQ ● https://www.youtube.com/playlist?list=PL8bSwVy8_IcO1kFUjq-9rU12u2JYU0u3-
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

VI SEMESTER			
NEURAL NETWORK & FUZZY LOGIC SYSTEMS			
Course Code	**21AR641**	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:

Students will be able

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in vaRIous systems.
- To provide adequate knowledge about fuzzy set theory

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. Adopt flipped classroom teaching method.
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. – Neural Networks, Application Scope of Neural Networks, Fuzzy Logic, GeneRIc AlgoRIthm, HybRId Systems, Soft Computing. Artificial Neural Network: An Introduction. – Fundamental Concept, Evolution of Neural Networks, Basic models of Artificial Neural Networks (ANN), Important Technologies of ANNs, McCulloch-Pitts Neuron, Linear Separability.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2	**8 HOURS**
Hebb Network and simple problems, Supervised Learning Network – Introduction -Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3	**8 HOURS**
Back -Propagation Network. – Theory, Architecture, Flowchart for trining process, Trining AlgoRIthm, Learning Factors of Back-Propagation Network, Testing AlgoRIthm of Back-Propagation Network. Radial Basis Function Network, Time Delay Neural Network, Functional Link Networks, Tree Neural Networks, wavelet neural network.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4	**8 HOURS**
Introduction to Fuzzy Logic, Classical sets and Fuzzy sets. Introduction to Fuzzy Logic, Classical sets (cRIsp sets) – Operations on Classical sets, Properties of Classical sets, Function of Mapping of Classical sets. Fuzzy sets – Fuzzy set operations, Properties of fuzzy sets. Simple Problems Classical Relations and Fuzzy Relations – Introduction, Cartesian Product of Relation, Classical Relation, Fuzzy Relation, Tolerance and Equivalence Relations, Non-interactive Fuzzy sets, Simple Problems.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE 5	**8 HOURS**
Membership Functions – Introduction, Features of the Membership functions, Fuzzication, Methods of Membership Value Assignments, Simple Problems Defuzzification- Introduction, Lamba-cuts for Fuzzy sets (Alpha-Cuts), Lamba-Cuts for Fuzzy Relation, Defuzzification Methods. Fuzzy Logic Control Systems – Introduction, Control System Design, Architecture and Operation of FLC system, FLC system Models, Application of FLC systems.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Compare and contrast the biological neural network and ANN.
- Discuss the ANN for pattern classification.
- Develop and configure ANN'swith different types of functions and learning algoRIthms.
- Apply ANN for real world problems.
- Discuss the fundamentals of fuzzy logic, implementation and their functions
- Apply fuzzy logic concepts in building automated control 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**)

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
4. 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)**

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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources: **Text Books:** S. N. Sivanandam and S.N. Deepa, PRInciples of Soft Computing, 2nd Edition, Wiley India Pvt. Ltd.-2014. Timothy J. Ross, Fuzzy logic with engineeRIng applications, McGraw Hill International Edition, 1997 **Reference Books:** Simon Haykin, Neural Networks: A comprehensive foundation, 2nd Edition, PHI, 1998.
Web links and Video Lectures (e-Resources):
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

VI SEMESTER			
MICRO ROBOTICS			
Course Code	**21AR642**	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	03

Course objectives:

- Provide brief introduction to micromachining and the principles of microsystems
- Understand the various flexures, actuators and sensor systems.
- Discuss the methods of implementation of micro robots.

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. Adopt flipped classroom teaching method.
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

Introduction

MST (Micro System Technology) – Micromachining - Working principles of Microsystems - Applications of Microsystems.

Scaling Laws and Materials for MEMS

Introduction - Scaling laws - Scaling effect on physical properties, scaling effects on Electrical properties, scaling effect on physical forces. Physics of Adhesion - Silicon-compatible material system - Shape memory alloys - Material properties: Piezoresistivity, Piezoelectricity and Thermoelectricity.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Flexures, Actuators and Sensors

Elemental flexures - Flexure systems - Mathematical formalism for flexures. Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuators. Electromagnetic sensors, Optical-based displacement sensors, Motion tracking with microscopes.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Micro robotics

Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Implementation of Micro robots

Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators. Micro-robotics devices: Micro-grippers and other micro-tools - Micro conveyors - Walking MEMS Micro-robots – Multi-robot system: Micro-robot powering, Micro-robot communication.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5

Micro fabrication and Micro Assembly:

Micro fabrication principles- Design selection criteria for micromachining – Packaging and Integration aspects – Micro –assembly platform and manipulators.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Describe the principles of microsystems and micromachining.
- Analyze the effectsof scaling laws on physical and electrical properties and the materials to be used to MEMS.
- Specify the characteristics of various flexures, actuators and sensor systems
- Provide a task specification of micro robots and its applications based on the knowledge about micro robots
- Outline the various methods of implementation of micro robots.
  Discuss about the principle of micro fabrication and micro assembly.

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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

- The MEMS Handbook, Mohamed Gad el-Hak, CRC Press, New York, 2002
- Microrobotics Methods and Applications Yves Bellouard CRC Press, MassachusettS, 2011
- An Introduction to Microelectromechanical systems Engineering NadimMaluf and Kirt Williams, Artech House, MA 2002
- Microsensors: Principles and Applications Julian W Gardner, John Wiley & Sons, 1994
- Microsystem Technology and Microrobotics SergejFatikow, Ulrich Rembold Springer 2013

Web links and Video Lectures (e-Resources):

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

VI SEMESTER			
Fluid Power Automation			
Course Code	**21AR643**	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	01	Exam Hours	03

Course objectives:

- To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.
- To train the students in designing the hydraulic and pneumatic circuits using various design procedures.

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. Adopt flipped classroom teaching method.
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 INTRODUCTION

Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 FLUID POWER GENERATING/UTILIZING ELEMENTS

Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification- Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 CONTROL AND REGULATION ELEMENTS

Direction flow and pressure control valves- Methods of actuation, types, sizing of portspressure and temperature compensation, overlapped and underlapped spool valvesoperating characteristicselectro hydraulic servo valves-Different types-characteristics and performance.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 CIRCUIT DESIGN

Typical industrial hydraulic circuits- Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

CO1: Identify and analyse the functional requirements of a fluid power transmission system for a given application.

CO2: Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.

CO3: Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro- pneumatics for a given application.

CO4: Select and size the different components of the circuit.

CO5: Develop a comprehensive circuit diagram by integrating the components selected for the given 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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988.
2. Dudbey. A. Peace, Basic Fluid Power, Prentice Hall Inc, 1967.
3. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978.
4. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967.
5. Peter Rohner, Fluid Power Logic Circuit Design, Mcmelan Prem, 1994.
6. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979.

7. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.
Web links and Video Lectures (e-Resources):
● Fluid Power, Automation Studio P6 recorded webinar https://www.youtube.com/watch?v=3xjB66zpnKI ● INDUSTRIAL AUTOMATION https://www.tce.edu/tce-mooc/21tocmt02
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

VI SEMESTER			
Automation in Manufacturing			
Course Code	**21AR644**	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:

- Describe the basic concepts of automation in manufacturing systems.
- Acquire the fundamental concepts of automated flow lines and their
- analysis.
- Classify automated material handling, automated storage and retrieval systems.
- Illustrate adaptive control systems and automated inspection methods.

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. Adopt flipped classroom teaching method.
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 OVER VIEW OF MANUFACTURING AND AUTOMATION

Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 MANUFACTURING SYSTEMS AND AUTOMATED PRODUCTION LINES

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 AUTOMATED ASSEMBLY SYSTEMS

Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 QUALITY CONTROL AND SUPPORT SYSTEMS	
Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

CO1: Illustrate the basic concepts of automation in machine tools.

CO2: Analyze various automated flow lines, Explain assembly systems and line balancing methods.

CO3: Describe the importance of automated material handling and storage systems.

CO4: Interpret 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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

- Automation, production systems and computer integrated manufacturing/ Mikell.P Groover/PHI/3 rd edition/2012.
- Automation, Production Systems and CIM/ Mike J P. Grower/PHI
- CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.
- System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
- Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009.
- Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers.

Web links and Video Lectures (e-Resources):

- INDUSTRIAL AUTOMATION https://www.tce.edu/tce-mooc/21tocmt02
- Automation in Manufacturing https://www.youtube.com/watch?v=632Y_uxsBFs

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

VI SEMESTER			
Fundamentals of Robotics			
Course Code	**21AR651**	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:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

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. Adopt flipped classroom teaching method.
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 BASIC CONCEPTS

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and controlissues- Various manipulators – Sensors - work cell - Programming languages.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 DIRECT AND INVERSE KINEMATICS

Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints-Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 MANIPULATOR DIFFERENTIAL MOTION AND STATICS

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 PATH PLANNING

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 DYNAMICS AND CONTROL

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

CO1: Understand basic concept of robotics.

CO2: Analyze Instrumentation systems and their applications to various

CO3: Know about the differential motion add statics in robotics

CO4: Know about the various path planning techniques.

CO5: Know about the dynamics and control in robotics industries.

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**)

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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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

TEXT BOOKS:

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

REFERENCES:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.

5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

Web links and Video Lectures (e-Resources):

- Robotics - NPTEL https://nptel.ac.in/courses/112108298

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

VI SEMESTER			
Introduction to PLC			
Course Code	**21AR652**	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:

- The fundamentals of Automation.
- The concept of PLC and its Programming using Ladder Diagram.
- The basics of HMI and Installations in PLC.

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. Adopt flipped classroom teaching method.
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 Introduction To Factory Automation

History and developments in industrial automation. Vertical integration of industrial automation, Control elements in industrial automation, PLC introduction.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2 Programmable Logic Controllers

Basics of PLC, Advantages, Capabilities of PLC, Architecture of PLC, Scan cycle, Types of PLC, Types of I/O modules, Power supplies and isolators, configuring a PLC, PLC wiring.

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3 Programming Of PLC

General PLC programming procedures - Types of Programming -Programming on-off inputs/outputsSimple process control programs using Relay Ladder Logic - Auxiliary commands and functions – PLC Basic Functions - Register basics - Timer functions – Counter.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4 PLC Intermediate Functions

PLC intermediate functions: Arithmetic functions, Comparison functions, Skip and MCR functions, Data move systems - PLC Advanced intermediate functions: Utilizing digital bits, Sequencer functions, Matrix functions – PLC Advanced functions: Alternate programming languages, Analog PLC operation

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5 HMI Systems & Installation of PLC

Necessity and Role in Industrial Automation, Text display - operator panels - Touch panels – Panel PCs - Integrated displays, interfacing PLC to HMI.

Installation and maintenance procedures for PLC - Troubleshooting of PLC, PLC NetworkingNetworking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet. Case studies

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

CO1: Identify and understand the automation concepts for Industries.
CO2: Apply PLC architecture knowledge to select PLC for specific problems.
CO3 Use PLC Ladder diagram for simple applications
CO4: Design real time application using PLC.
CO5: Create prototype for the real time application Using PLC,with HMI
CO6: Recognize the faults and identify the protocol to be used for the 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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text books:

1. John W Webb & Ronald A Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.
2. Frank D Petruzella "Programmable Logic Controllers ", McGraw Hill Inc, 2005

Reference Books:

1. Bolton W. , "Mechatronics", Pearson Education, 2009
2. Kelvin T Erikson, "Programmable Logic Controllers ", Dogwood Valley Press, 2005.
3. Garry Dunning, "Introduction to Programmable Logic Controllers", Thomson Delmar Learning, 2005.
4. Khalid Kamel, Eman Kamel, "Programmable Logic Controllers", McGrawhill,2013.

Web links and Video Lectures (e-Resources):

- Robotics - NPTEL https://nptel.ac.in/courses/112108298

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

1

FINITE ELEMENT ANALYSIS LAB			
Course Code	**21ARL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	02	Exam Hours	03
**** Additional One hour may be considered for instructions if required***			

Course objectives:

- To learn the basic principles of finite element analysis procedure
- To understand heat transfer problems with application of FEM.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.
- To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Sl.NO	Experiments
1	Introduction to FEA software, Preprocessing tools, Solver tools and Postprocessing tools.
2	Analysis of Bars of constant cross section area, tapered cross section area and stepped bar subjected to Point forces, Surface forces and Body forces (Minimum 2 exercises of different types)
3	Analysis of trusses (Minimum 2 exercises of different types)
4	Analysis of Beams – Simply supported, cantilever, Propped cantilever beams with point load
5	Analysis of Beams – UDL, beams with varying load
6	Stress analysis of a rectangular plate with a circular hole.
7	Thermal Analysis – 1D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
8	Thermal Analysis – 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
	Demonstration Experiments (For CIE)
9	Dynamic Analysis to find: Natural frequency of beam with fixed – fixed end condition, Response of beam with fixed – fixed end conditions subjected to forcing function
10	Dynamic Analysis to find: Natural frequency of bar, Response of Bar subjected to forcing functions
11	Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.
12	Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.

Course outcomes (Course Skill Set):

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

- Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements.
- Develop element characteristic equation and generation of global equation.
- Formulate and solve Axi-symmetric and heat transfer problems.
- Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric and dynamic problems.

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:

Textbooks

1. A first course in the Finite Element Method, Logan, D. L, Cengage Learning, 6th Edition 2016.
2. Finite Element Method in Engineering, Rao, S. S, Pergaman Int. Library of Science 5th Edition 2010.
3. Finite Elements in Engineering Chandrupatla T. R PHI 2nd Edition 2013

Referencebooks

1. Finite Element Method, J.N.Reddy, McGraw -Hill International Edition.
2. Finite Elements Procedures Bathe K. J PHI

VII Semester

INDUSTRIAL ROBOTICS: Field and Service Robotics			
Course Code	**21AR71**	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:

- To know types of industrial robots.
- To Enlighten the students in the use robots for inspection.
- To Enlighten the students in different applications of robots.
- To develop the student's skills in understanding the selection of robots for different applications.
- To understand the advanced material handling methods.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

INTRODUCTION: Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.
History of service robotics – Present status and future trends – Need for service robots - applications- examples and Specifications of service and field Robots. Non conventional Industrial robots.

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-2

ROBOTS FOR INSPECTION: Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.
OTHER APPLICATIONS: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications**.**

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-3

LOCALIZATION
Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beaconsystems- Route based localization.
PLANNING AND NAVIGATION
Introduction-Path planning overview- Road map path planning- Cell decomposition path planning- Potential field path planning-Obstacle avoidance - Case studies: tiered robot architectures.

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-4	
FIELD ROBOTS Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-5	
HUMANOIDS Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision,Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Course outcome (Course Skill Set)

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

1: Use different types of robots for different industrial applications.
2: Analyze the different advanced inspection methods.
3: Understand the use of robots for other applications.
4: Selection of robots for different applications.
5: Understand more advanced material handling 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:

1. 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)

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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Richard D Klafter, Thomas Achmielewski and Mickael Negin, Robotic Engineering – An integrated Approach, Prentice Hall India, New Delhi, 2001.
2. Mikell P Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson Education, 2015.
3. James A Rehg, Introduction to Robotics in CIM Systems, Prentice Hall India, New Delhi, 2002.
4. Deb S.R. Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi.
5. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004
6. Riadh Siaer, „The future of Humanoid Robots- Research and applications" , Intech Publications, 2012.
7. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

Web links and Video Lectures (e-Resources):

- NPTEL :: Mechanical Engineering - NOC:Robotics https:/nptel.ac.in/courses/112/105/112105249
- VTU e-learning centre Swayam Prabha | 34 DTH channels | India Channel No.11 https:/swayamprabha.gov.in
- Audio/Video Lectures | MIT OpenCourseWare | Free Online Course Materials

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

- Visit to the industries/ reputed universities or colleges to explore the use of robots for various industrial applications.

VII Semester

Industrial Data Networks			
Course Code	**21AR72**	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:

- To educate on the basic concepts of data networks
- To introduce the basics of internetworking and serial communications
- To provide details on HART and Field buses
- To educate on MODBUS, PROFIBUS and other communication protocol
- To introduce industrial Ethernet and wireless communication

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1 INTRODUCTION	
Modern instrumentation and control systems – Terminology – Topology – Mechanisms - Protocols – Standards – Common problems and solutions – Grounding/shielding and noise - EIA-232 interface standard – EIA-485 interface standard –Current loop and EIA-485 converters - Fibre optic cable components and parameters – Basic cable types – Connection fibers – troubleshooting.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-2 COMMUNICATION BUS PROTOCOLS	
Overview – Protocol structure – Function codes – Modbus plus protocol –Data Highway – AS interface (AS-i)-DeviceNet: Physical layer – Topology – Device taps –Profibus PA/DP/FMS: Protocol stack – System operation. CAN BUS: Concepts of bus access and arbitration – CAN: Protocol-Errors: Properties – detection – processing – Introduction to CAN 2.0B	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-3 ETHERNET SYSTEMS	
IEEE 802.3 – Physical layer - Medium access control – Collisions - Ethernet design rules - Fast and gigbit Ethernet systems - design considerations - Internet layer protocol - UDP - TCP/IP - ProfiNet - LAN system components – Structured cabling – Industrial Ethernet – Troubleshooting Ethernet.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-4 WIRELESS COMMUNICATIONS	
Radio spectrum – Frequency allocation – Radio modem – Intermodulation – Implementing a radio link – RFID: Basic principles of radio frequency identification – Transponders – Interrogators, WirelessHART.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-5 APPLICATIONS	
Automotive communication technologies – Design of automotive X-by-Wire systems, - The LIN standard – The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Course outcome (Course Skill Set)

- At the end of the course the student will be able to:
- Ability to define basic concepts of data communication and its importance.
- Ability to explain the various internetworking devices involved in industrial networks
- Ability to explain the various serial communication used in process industries.
- Ability to illustrate, compare and explain the working of HART and Field bus used in process digital communication.
- Ability to summarize the operation of MODBUS, PROFIBUS protocol and its applications.
- Ability to explain and adopt the different Industrial Ethernet protocol and usage of wireless communication in process 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)

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

4. First assignment at the end of 4th week of the semester
5. 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)

6. 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)

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

1

Suggested Learning Resources:

TEXTBOOKS:

1. Steve Mackay, Edwin Wright, Deon Reynders and John Park, —Practical Industrial Data Networks: Design, Installation and
Troubleshooting‖, Newnes (Elsevier), 2004.
2. Dominique Paret, —Multiplexed Networks for Embedded Systems‖, John Wiley & Sons, 2007.

REFERENCES:

1. Richard Zurawski, —The Industrial Communication Technology Handbook‖, Taylor and Francis, 2005.
2. Deon Reynders and Edwin Wright, —Practical TCP/IP and Ethernet Networking‖, IDC Technologies, 2006.
3. James Powell, Henry Vandelinde, —Catching the Process Fieldbus an Introduction to PROFIBUS for Process Automation",
Momentum Press, 2013.
4. Albert Lozano-Nieto, —RFID Design Fundamentals and Applications‖, CRC Press, 2011

Web links and Video Lectures (e-Resources):

- Digital Protocols - Process Control https://www.coursera.org/lecture/sensor-manufacturing-process-control/6-digital-protocols-MaSd4
- Introduction to Industry 4.0 and Industrial Internet of Things https://onlinecourses.nptel.ac.in/noc20_cs24/preview

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

- Visit to the industries/ reputed universities or colleges to explore the applications of networking.

VII Semester

Total Quality Management			
Course Code	**21AR731**	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:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1	
Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-2	
Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-3	
Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-4	
Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-5	
Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Explain the various approaches of TQM CO2: Infer the customer perception of quality CO3: Analyse customer needs and perceptions to design feedback systems. CO4: Apply statistical tools for continuous improvement of systems CO5: Apply the tools and technique for effective implementation of TQM.	

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:

1. 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

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

1. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1 Total Quality Management Dale H. Besterfield Pearson Education India, Edition 03. ISBN:8129702606,
2 Total Quality Management for Engineers M. Zairi Wood head Publishing ISBN:1855730243

Reference Books

1 Managing for Quality and Performance Excellence James R. Evans and William M Lindsay Cengage Learning. 9th edition
2 Four revolutions in management Shoji Shiba, Alan Graham, David Walden Oregon 1990
3 Organizational Excellence through TQM H. Lal New age Publications 2008
4 Engineering Optimization Methods and Applications A Ravindran, K, M. Ragsdell Willey India Private Limited 2nd Edition,2006
5 Introduction to Operations Research- Concepts and Cases F.S. Hillier. G.J. Lieberman Tata McGraw Hill 9th Edition, 2011

Web links and Video Lectures (e-Resources):

- Total Quality Management - II - nptel online courses
  https://archive.nptel.ac.in/courses/110/104/110104085/
-

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

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VII Semester

Smart Manufacturing			
Course Code	**21AR732**	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:

- To present a problem oriented in depth knowledge of Smart Manufacturing.
- To address the underlying concepts and methods behind Smart Manufacturing.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1 Introduction to Smart Manufacturing	
What is "smart manufacturing" really and how does it differ from conventional/legacy manufacturing-Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG)	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-2 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.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-3 Smart Applications	
Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-4 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, Assisted/Augmented Assembly, Assisted/Augmented Quality, Assisted/Augmented Maintenance, Assisted/Augmented Warehouse Operations and Assisted Training	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-5 Thinking about Prototyping

Costs versus ease of prototyping, prototyping and Production, open source versus Closed Source. Prototyping Embedded devices – Electronics, Embedded Computing Basics, Arduino/ Raspberry Pi/ BeagleBone Black/ etc., Electric Imp and other notable platforms Prototyping of Physical Design. Prototyping online Components – Getting Started with an API, Writing a New API

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Course outcome (Course Skill Set)

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

1 The student can identify different areas of IOT and Smart Manufacturing.

2 Can find the applications of all the areas in day to day life.

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:

1. 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)

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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1 A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.

2 N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013, ISBN-10: 0071790152.

3 M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992.

Web links and Video Lectures (e-Resources):

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

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VII Semester

Motors Drives and Power Electronics			
Course Code	**21AR741**	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:

- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and imitations.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-2

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics of GTO, MCT, FCT, RCT

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-3

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - and IGCT. New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) - Comparison of all power devices.Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-4	
Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.
Module-5	
Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase duel Converters. AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads,Three-Phase Full-Wave Controllers.	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Course outcome (Course Skill Set)

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

CO1: To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.

CO2: To explain the techniques for design and analysis of single phase diode rectifier circuits.

CO3: To explain different power transistors, their steady state and switching characteristics and limitations.

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:

1. 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)

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. Marks scored out of 100 shall be reduced proportionally to 50 marks

1

Suggested Learning Resources: **Books** 1 A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X. 2 N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013, ISBN-10: 0071790152. 3 M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992.
Web links and Video Lectures (e-Resources):
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

VII Semester

Digital Image Processing			
Course Code	**21AR742**	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:

- Understand the fundamentals of digital image processing
- Understand the image transform used in digital image processing
- Understand the image enhancement techniques used in digital image processing
- Understand the image restoration techniques and methods used in digital image processing
- Understand the Morphological Operations and Segmentation used in digital image processing

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1	
Digital Image Fundamentals: What is Digital Image Processing?, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. [Text: Chapter 1 and Chapter 2: Sections 2.1 to 2.5, 2.6.2] L1, L2	
Pedagogy	Power point presentation MATLAB demonstration of Acquisition, Image Sampling and Quantization
Module-2	
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters Frequency Domain: Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. [Text: Chapter 3: Sections 3.2 to 3.6 and Chapter 4: Sections 4.2, 4.5 to 4.10] L1, L2, L3	
Pedagogy	Power point presentation solving numerical for filtering MATLAB demonstration of Image Smoothing and Image Sharpening
Module-3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. [Text: Chapter 5: Sections 5.2, to 5.9] L1, L2, L3	
Pedagogy	Power Point Presentations and Videos. Discussion on current research from the research papers, patents.

Module-4	
Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing. Wavelets: Background, Multiresolution Expansions. Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. [Text: Chapter 6: Sections 6.1 to 6.3, Chapter 7: Sections 7.1 and 7.2, Chapter 9: Sections 9.1 to 9.5] L1, L2, L3	
Pedagogy	Power point presentation solving numerical for noise models MATLAB demonstration of applying Inverse Filtering, minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering
Module-5	
Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds. Representation and Description: Representation, Boundary descriptors. [Text: Chapter 10: Sections 10.2, to 10.5 and Chapter 11: Sections 11.1 and 11.2] L1, L2, L3	
Pedagogy	Power point presentation solving numerical for noise models MATLAB demonstration of applying Edge Detection Application videos

Course outcome (Course Skill Set)

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

CO1: To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.

CO2: To explain the techniques for design and analysis of single phase diode rectifier circuits.

CO3: To explain different power transistors, their steady state and switching characteristics and limitations.

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:

1. 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
5. Two assignments each of 10 Marks
6. First assignment at the end of 4th week of the semester
7. 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)

9. The question paper will have ten questions. Each question is set for 20 marks.
10. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Book:

1. Digital Image Processing- Rafel C Gonzalez and Richard E. Woods, PHI 3rd Edition 2010.

REFERENCE:

1. Digital Image Processing- S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata McGraw Hill 2014.
2. Fundamentals of Digital Image Processing-A. K. Jain, Pearson 2004.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117/105/117105079/
- https://www.youtube.com/watch?v=9uUAadvgqdE
- https://www.youtube.com/watch?v=CVV0TvNK6pk
- https://www.youtube.com/watch?v=svgZodJgKaU

etc.....

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

- https://www.javatpoint.com/digital-image-processing-tutorial
- https://www.tutorialspoint.com/dip/index.htm

etc.....

VII SEMESTER			
INTRODUCTION TO MOBILE ROBOTICS			
Course Code	**21AR751**	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:

- Provide knowledge on the application of mobile robotics

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

INTRODUCTION: Telerobotics: Overview and background – Brief history.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

COMMUNICATIONS AND NETWORKING: The Internet – Wired Communication Links – Wireless Links – Properties of Networked Telerobotics – Building a Networked Telerobotic system – State command Presentation – Command Execution/ State Generation – Collaborative Control

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

FUNDAMENTALS OF ONLINE ROBOTS: Introduction – Robot Manipulators – Teleoperation – Teleoperation on a local network – Teleoperation via a constrained link.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

ONLINE ROBOTS: Introduction to networked robot system on the Web – Software Architecture and design – Interface design.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5

CASE STUDY:Performance of mobile robots controlled through the web – System Description – Software Architecture.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Understand the development and operation of mobile robotics.

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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

3. Bruno Siciliano, Oussama Khatib, —Springer Handbook of Robotics||, Springer Science and Business, 2010.
4. Ken Goldberg, Roland Siegwart, —Beyond Webcams – An Introduction to Online Robots||, MIT Press, 2010.

Reference

1. Borko Furht, Armando Escalante, —"Handbook of Cloud Computing", Springer Science & Business, 2010.
2. Peter Sinčák, Pitoyo Hartono, Mária Virčíková, Ján Vaščák, Rudolf Jakša , —"Emergent Trends in Robotics and Intelligent Systems", Springer, 2014.

Web links and Video Lectures (e-Resources):

- Control of Multiple Robots - Advanced Topics https://www.coursera.org/lecture/robotics-flight/control-of-multiple-robots-sLAoY

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

VII SEMESTER			
INTRODUCTION TO Automation			
Course Code	**21AR752**	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:

- To impart knowledge of CIM and Automation and different concepts of automation
- To understand how to automate an industrial process using PLC.
- To understand the instructions of PLC
- To program PLC using the Ladder diagrams.
- To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.

Pedagogy (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) 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.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Automated production lines:

Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3

Basic concepts of PLC, PLC components – I/O configuration, Introduction to PLC operation, Binary data representation, Input and Output status files, sixteen point I/O modules, PLC memory

Architecture of PLC:- Modular and brick type.I/O Modules: D/I, D/O, A/I, A/O and communication modules. PLC symbols, Advantages and Disadvantages of PLC, List PLC applications. Communication to PC and PLC through serial, MODBUS, Ethernet	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	**3 HOURS**
COMMUNICATIONS AND NETWORKING: The Internet – Wired Communication Links – Wireless Links – Properties of Networked Telerobotics – Building a Networked Telerobotic system – State command Presentation – Command Execution/ State Generation – Collaborative Control	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

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

- Define Automation and explain the basics of automated manufacturing industries.
- Describe working of various blocks of basic industrial automation system
- Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.
- Understand the operation of mobile robotics

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**)

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**

4. First assignment at the end of 4th week of the semester
5. 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**)

6. 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)**

7. The question paper will have ten questions. Each question is set for 20 marks.
8. 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. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1 Automation, Production Systems and Computer-Integrated Manufacturing Mikell P Groover Pearson Learning. 4th Edition,2015

2 W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.

3 Introduction to Programmable Logic Controllers by Garry Dunning, Thomson, 2nd edition, Thomson, ISBN: 981-240-625-5

4 Ken Goldberg, Roland Siegwart, —Beyond Webcams – An Introduction to Online Robots||, MIT Press, 2010.

Reference

1. Borko Furht, Armando Escalante, —"Handbook of Cloud Computing", Springer Science & Business, 2010.

2. Peter Sinčák, Pitoyo Hartono, Mária Virčíková, Ján Vaščák, Rudolf Jakša , —"Emergent Trends in Robotics and Intelligent Systems", Springer, 2014.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_me120/preview

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