VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2021 - 22)

III Semester

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES			
Course Code (BSC)	**21MAT31**	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 21MAT 31 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):

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

1. 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.
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

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

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

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

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series

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

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

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

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

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

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations

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

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

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Self Study: Hanging chain problem

(RBT Levels: L1, L2 and L3)

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

- 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 Engineering Mathematics", 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. Ltd 2015.
6. **H.K.Dass and 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

ANALOG ELECTRONIC CIRCUITS			
Course Code (IPCC)	**21EI/BM32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	4	Exam Hours	03

Course objectives: This course will enable the students to

- Describe the types of BJT/ FET biasing, and Demonstrate the use of BJT/FET amplifiers
- Understand the modeling of BJT/FET for analysis and to design of BJT/FET Amplifiers
- Understand and Demonstrate Generalized Frequency response of BJT and FET amplifiers.
- Design and analyze Power amplifier circuits.
- Understand the concept of Feedback and its effect on amplifier circuits and Oscillator circuits.
- Understand the basics of Power Electronic systems

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Show Video/animation films to explain evolution of communication technologies.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.

MODULE-1

DC Biasing – BJT's

Introduction, operating point, Fixed-bias configuration, Emitter-bias configuration, Voltage-divider biasing, Emitter follower configuration. Relevant numerical problems.

DC Biasing – FET's

Introduction, Fixed-bias configuration, Self-bias configuration, Voltage-divider biasing, Relevant numerical problems.

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Collector feedback bias, Transistor switching networks, Bias stabilization **RBT Level:** L1, L2, L3

MODULE-2

BJT AC Analysis

BJT modeling, re transistor model: Common Emitter fixed bias configuration, Voltage-divider bias, CE Emitter-bias configuration (Excluding P-spice Analysis), Emitter follower configuration, Cascaded Systems. The Hybrid equivalent model, Approximate Hybrid equivalent circuit, Fixed bias configuration, Voltage-divider configuration, Hybrid π model

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Design of Common Emitter RC coupled amplifier circuits. **RBT Level:** L1, L2, L3

MODULE-3

FET Amplifiers

Introduction, JFET Small signal model, JFET AC equivalent circuit, Fixed- bias configuration, Self-bias configuration (with bypassed Rs only), Voltage-divider bias configuration, Source follower configuration.

BJT and JFET Frequency Response:

Introduction, General Frequency Considerations, Low Frequency Response of BJT Amplifier, Low Frequency Response of FET Amplifier, Miller Effect Capacitance, Multistage frequency effects

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Depletion and Enhancement type MOSFET's, High frequency response of BJT/FET Amplifier

	RBT Level: L1, L2, L3

MODULE-4	
Power Amplifiers:- Introduction: Definitions and Amplifier Types, Series Fed Class A Amplifier, Transformer Coupled Class A Amplifier, Class B Amplifier operation. Class B amplifier circuits:-Transformer-Coupled Push-Pull, Complementary–Symmetry, Amplifier Distortion **Feedback and Oscillator Circuits:-** Feedback concepts, Feedback connection types, effects of negative feedback, practical feedback circuits: -BJT based current series and voltage shunt feedback. Oscillator operation, Barkhaunsen's criteria, RC phase oscillator using BJT, Tuned oscillator Circuits: BJT based Hartley oscillator, Transistor Crystal oscillator	
Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Determination of second harmonic distortion, voltage series feedback amplifier circuit, Colpitts oscillator using BJT/FET **RBT Level:** L1, L2, L3

MODULE-5	
Overview of Power Electronic Systems: Power Electronic Systems, Power semiconductor devices, Power Electronic Converters and Applications. **Thyristors:** Construction and operation of SCR, Static V-I characteristics, Two transistor model, Turn-ON methods, Turn OFF methods, Comparison between Transistors and Thyristors **Gate Trigger Circuit:** Resistance Firing Circuit, Resistance capacitance firing circuit, Unijunction Transistor: Basic operation and UJT Firing Circuit	
Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Thyristor ratings, Pulse transformer triggering circuits, optical isolators, Block diagram of UPS **RBT Level:** L1, L2, L3

PRACTICAL COMPONENT

Sl.NO	Experiments
1	Determination of ripple factor and efficiency of full wave rectifier using center-tapped transformer
2	Determination of ripple factor and efficiency of full wave bridge rectifier
3	Static V-I characteristics of UJT
4	Static V-I characteristics of SCR
5	Design and testing of Common emitter BJT voltage divider biasing circuit
6	Frequency response of single stage BJT RC coupled amplifier
7	Drain characteristics and transfer characteristics of JFET
8	Testing of Complementary symmetry class B push-pull amplifier
9	Study of RC phase shift oscillator using BJT
10	Study of Common source JFET amplifier
11	Study of Crystal oscillator using BJT

12	Study of AC voltage controller using TRIAC and DIAC

Course outcomes (Course Skill Set):

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

1. Design and implement a biasing circuit for BJT and FET
2. Model the BJT/FET amplifier for ac analysis
3. Analyze Frequency response of BJT and FET amplifier
4. Acquire the knowledge of classifications of Power amplifier, operation, and design power amplifier
5. Understand the feedback concepts and designing of oscillator circuits
6. Understand the power electronic devices and basic power electronic circuits.

Assessment Details (both CIE and SEE)

The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

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

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

Two assignments each of **10 Marks**

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

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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

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

Suggested Learning Resources:

Text Books

1. Electronic Devices and Circuit Theory-Robert L Boylestad, Louis Nashelsky, 10th edition, PEARSON
2. Power Electronics-M D Singh, K B Khanchandani, Second edition 2012, McGraw-Hill

Reference Books

1. Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Millman, Christos C. Halkias, McGraw-Hill, 2015
2. Electronic Devices and Circuits, David A Bell, 5th edition, OXFORD University press

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108102112
- https://nptel.ac.in/courses/108105158
- http://elearning.vtu.ac.in/econtent/ECE.php#
- http://elearning.vtu.ac.in/econtent/courses/video/ECE/06ES32.html
- http://elearning.vtu.ac.in/econtent/courses/video/ECE/Analog_Electronics_Lab.html

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

- Quizzes
- Surprise Tests
- Assignments
- Seminars

DIGITAL DESIGN AND HDL			
Course Code (IPCC)	**21EI/BM33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3

Course objectives:

- To impart the concepts of simplifying Boolean expression using K-map techniques and Quin- McCluskey minimization techniques.
- To impart the concepts of designing and analyzing combinational logic circuits.
- To impart design methods and analysis of sequential logic circuits.
- To impart the concepts of HDL-Verilog data flow and behavioral models for the design of digital systems.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes criticalthinking
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinkingskills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up withtheir own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.

MODULE-1

Principles of Combinational Logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps- up to 4 variables, Quine-McCluskey Minimization Technique. Quine-McCluskey using Don't Care Terms.
(Text 1).

Teaching-Learning Process	Chalk and talk method. RBT Level L2 L3 L4

MODULE-2

Logic Design with MSI Components and Programmable Logic Devices:
Binary Adders and Subtractors, Comparators, Encoders, Multiplexers, Programmable Logic Devices (PLDs), Programmable Read only Memories (PROMS). (Text 2)

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L1 L2 L3

MODULE-3

Flip-Flops:
Latches, Timing Considerations, The Master-Slave Flip-flops (Pulse-Triggered flip-flops): SR flip-flops, JK flip flops, Additional types of Master-Slave Flip-flops, Edge Triggered Flip-flops- The positive Edge triggered D Flip-flop, Characteristic equations. (Text 2)

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L1 L2 L3

MODULE-4

Simple Flip-Flops Applications: Registers, Binary Ripple Counters, Counters based on Shift Registers, Design of Synchronous Mod-N Counter using clocked T , JK , D and SR flip-flops. Self-correcting counters(Text 2).

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L2 L3 L4

MODULE 5

Introduction to Verilog: Structure of Verilog module, Operators, Data Types, Styles of Description- Data flow description, Behavioral description. Implementation of half adder and full adder using Verilog data flow description. **Verilog Behavioral description:** Structure, Sequential Statements, Case statement, Loop Statements, Verilog Behavioral Description of Multiplexers(2:1,4:1,8:1). (Text 3)	
Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L3 L4 L5

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

Sl.NO	Experiments
1	Simplification, realization of Boolean expressions using logic gates/Universal Gates
2	To design and implement (a) Adder/Subtractor – Full/half using logic gates. (b) 4-bit Parallel Adder/ subtractor using IC 7483.
3	To realize (a)Binary to Gray code conversion and vice versa (b)Priority encoder and 3:8 Decoder using IC74138 (c)One / Two bit comparator
4	To realize the following flip-flops using NAND Gates T type (b) JK Master slave (c) D type
5	To design and implement the 3-bit Mod-N synchronous counters using 7476.
6	Adder/Subtractor – Full/half using Verilog data flow description
7	Flip-flops using Verilog Behavioral description (a) JK type b) SR type c) T type and d) D type
8	Counter Up/ Down (Binary), sequential counters using Verilog.
Demonstration Experiments(for CIE) Use FPGA/CPLD kits for downloading verilog codes and check the output for interfacing experiments.	
9	Verilog program to interface a stepper motor to rotate the motor in specified direction
10	Verilog program to interface a Relay
11	Verilog program to interface a Waveform generation using DAC
12	Verilog program to interface switches and LEDs

Course outcomes (Course Skill Set):

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

1. Simplify Boolean functions using K-map and Quine-McCluskey minimization technique
2. Analyze and design for combinational logic circuits.
3. Analyze the concepts of Latches and Flip Flops. (SR, D, T and JK).
4. Analyze and design the synchronous sequential circuits.
5. Implement Combinational circuits(adders, subtractors, multiplexers) & sequential circuits using Verilog descriptions..

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

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:

1. Digita**l** Logic Applications and Design by John M Yarbrough, Thomson Learning,2001
2. Digital Principles and Design by Donald D. Givone, McGraw Hill, 2002.
3. HDL Programming VHDL and Verilog by Nazeih M. Botros, 2009 reprint, Dreamtech press.

Reference Books:

1. Fundamentals of logic design, by Charles H Roth Jr., Cengage Learning

2. Digital Principles and Design – Donald D Givone,12th reprint, TMH,2008
3. Logic Design, Sudhakar Samuel, Pearson/ Saguine, 2007
4. Fundamentals of HDL- Cyril P R Pearson/Sanguin 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105132
- https://nptel.ac.in/courses/117105080
- https://nptel.ac.in/courses/108103179
- http://elearning.vtu.ac.in/econtent/courses/video/ECE/18EC34.html
- http://elearning.vtu.ac.in/econtent/courses/video/ECE/10ESL38.html
- http://elearning.vtu.ac.in/econtent/courses/video/ECE/06EC667.html

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

Programming Assignments / Mini Projects can be given to improve programming skills

MEASUREMENT AND TRANSDUCERS			
Course Code (PCC)	**21EI34**	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 provide the fundamental knowledge of measurement, instrumentation and transducers.
- To understand the functional elements of instrumentation/measurement systems.
- To impart the basic concepts of digital instruments, oscilloscope and signal generators.
- To develop the skills for the measurement of Resistance, Capacitance, Inductance, and Frequency.
- To illustrate the principle, design and working of transducers for the measurement of displacement, strain and temperature.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Introduce the topics in a manifold representation.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Measurement, Functional Elements of Measurement System and Transducers:

Measurement, significance of measurement, instruments and measurement systems, mechanical, electrical and electronic instruments, Deflection & Null type instruments and their comparison, Analog and digital modes of operation, functions of instruments and measurement systems, applications of measurement systems, Elements of generalized measurement system, Input-output configuration of measuring instruments and measurement systems, methods of correction for interfering and modifying inputs. Transducers, Classifications of transducers- primary & secondary, active & passive, analog and digital transducers.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-2

Digital Voltmeters, Digital Multimeters and Frequency Meters:

Introduction, Ramp technique & ramp type DVM, Dual slope integrating type DVM, Successive approximation DVM, Resolution and sensitivity of digital meters. Digital multimeters, Digital frequency meter.

Oscilloscope: Introduction, Basic principle, CRT features, Block diagram of oscilloscope, Dual beam oscilloscope, Dual trace oscilloscope.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-3

Signal Generators: Introduction, Fixed and variable AF oscillator, Standard signal generator, Modern laboratory signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator.

Bridge Circuits for Measurement of R, L & C:

DC bridges: Introduction, Wheatstone bridge, Kelvin Bridge, Practical Kelvin's double bridge.

AC bridges: Capacitance Comparison Bridge, Inductance Comparison Bridge, Maxwell's bridge, Schering Bridge, Wien's bridge. (Relevant problems)

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-4	
Measurement of Displacement: Introduction, Principles of Transduction: Variable resistance devices, Variable Inductance Transducer, Synchros and Resolvers, Variable Capacitance Transducer, Hall Effect Devices, Proximity Devices, Digital Transducer **Measurement of Strain:** Introduction, Electrical Strain Gauges, Theory of operation of resistance strain gauges, Types of Electrical Strain Gauges – Wire gauges, unbounded strain gauges, foil gauges, Semiconductor strain gauges (principle, types & list of characteristics only), Materials for strain gauges. Wheatstone bride circuit for strain gauges, Applications	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links.
Module-5	
Measurement of Temperature: Introduction, Mechanical temperature sensors, Resistance type temperature sensors, platinum resistance thermometer, thermistors (principle, types & characteristics), thermocouples, solid state sensors – principle and working, brief discussion on AD590 (characteristics and features), LM35 (characteristics and features), Quartz thermometer, Temperature measurement by radiation methods, Optical pyrometer, Calibration of thermometers.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

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

1. Define the measurement, instrument, transducer, and explain the functional elements of generalized instrumentation / measurement system.
2. Explain the principle and working of digital instruments, oscilloscopes and function generators.
3. Analyze and use appropriate circuits for the measurement of resistance, capacitance, inductance and frequency.
4. Discuss the principle, construction and working of transducers for the measurement of displacement and strain.
5. Discuss the principle, construction and working of transducers for the measurement of temperature.

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)**

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:

Textbooks:

1. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.(Module-1).
2. Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012 (Module-2 & 3)
3. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 4 & 5).

Reference Books:

1. Electronic Instrumentation and Measurements - David A Bell, 3rd Edition, Oxford University Press, 2013.
2. Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009.
3. Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007.
4. Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009.
5. Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105153
- https://nptel.ac.in/courses/108105064
- https://www.youtube.com/watch?v=hxf0dn8Bjh8
- https://www.youtube.com/watch?v=As5kzxkyT24

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

- Explore the use of different type of instruments and transducers being used in the real world situation.
- Demonstration of instruments and transducers in the laboratory.
- Develop mini projects using instruments and transducers.

MEASUREMENT AND TRANSDUCERS LAB			
Course Code (PCC Lab)	21EIL35	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course Objectives: This Lab course will enable the students to

- Develop the skills for the measurement of Resistance, Capacitance, Inductance, and Frequency.
- Understand the working principle of sensors and transducer.
- Test the response and plot the characteristics of different transducers
- Interpret and analyze experimental results with theoretical concepts.
- Study and interpret data sheets of different transducers to select the suitable transducer for particular application and safe operation.

Sl. No.	Experiments
1	Measurement of unknown resistance by Wheatstone bridge and finding the sensitivity of the bridge.
2	Measurement of low resistance using Kelvin double bridge.
3	Measurement of self-inductance using Maxwell's bridge.
4	Measurement of unknown capacitance using Schering's bridge.
5	Measurement of displacement using LVDT and finding the sensitivity & resolution.
6	Characteristics of Load cell and Cantilever beam using Strain gauge: Plotting the characteristics and finding their sensitivity for Quarter, Half and Full bridge configurations.
7	Temperature measurement using RTD, Thermistor and Thermocouple: Plotting the characteristics and finding their sensitivity.
8	Temperature measurement using AD590 / LM35: Plotting the characteristics and finding their sensitivity.
9	Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance, and Plotting their characteristics.
10	Calibration of voltmeter and ammeter using DC potentiometer.
11	Characteristics of potentiometric transducer/capacitance transducer
12	Measurement of unknown capacitance/frequency using Wein's bridge.

Course Outcomes: After studying this course, students will able to:

- Measure unknown values of resistance, capacitance and inductance using different bridges.
- Analyze the response and plot the characteristics of displacement measuring transducers such as LVDT and Potentiometric transducer.
- Analyze the response and plot the characteristics of temperature measurement transducers such as RTD, Thermistor, Thermocouple, AD590 and LM35.
- Analyze the response and plot the characteristics of strain gauge type load cell.
- Design , build and test the circuits for practical applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.
The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course is 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup 20%, conduction, procedure and result is 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. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.
2. Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012
3. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014.

SOCIAL CONNECT AND RESPONSIBILITY			
Course Code (UHV)	**21SCR36**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

SAMSKRUTIKA KANNADA			
Course Code (HSMC)	21KSK37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

BALAKE KANNADA			
Course Code (HSMC)	21KBK37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS			
Course Code (HSMC)	21CIP37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

STATIC & DYNAMIC CHARACTERISTICS AND ERROR ANALYSIS IN INSTRUMENTATION SYSTEMS			
Course Code (AEC-III Theory)	**21EI381**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

Course Objectives:

- To impart fundamentals of static and dynamic characteristics of instrumentation systems.
- To acquire the basic knowledge of errors in measurement systems and their analysis.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts static and dynamic characteristics.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1	
Measurement system performance, Static calibration and error calibration curve, accuracy and precision, indications of precision, significant figures, static error, static correction, scale range and scale span, reproducibility and drift, repeatability, static sensitivity, linearity, hysteresis, threshold, dead time and dead zone, resolution	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1 and L2
Module-2	
Noise, signal to noise ratio, sources of noise, Johnson noise, power spectrum density, noise factor and noise figure, loading effects, Input and output impedances – input impedance, input admittance, output impedance, output admittance, generalized impedance and stiffness concepts, static stiffness and static compliance.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1 and L2
Module-3	
Limiting errors, relative limiting errors, types of errors, gross errors, systematic errors, random errors, central value, Statistical treatment of data – histogram, arithmetic mean, measure of dispersion from the mean, range, average deviation, standard deviation, variance, normal or Gaussian curve of errors, probable error.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2 and L3
Module-4	
Dynamic response – steady state and transient response, dynamic characteristics, Dynamic analysis of measurement systems – time domain analysis, different types of inputs, frequency domain analysis, Transfer function, Time domain response – zero order system, first order system, response of a first order system to step & ramp input, frequency response of first order system.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2 and L3
Module-5	
Response of second order systems – overdamped, critically damped and underdamped systems, Step response of second order system, time domain specifications, Frequency response of first order system, frequency response of second order system, dead-time elements.	

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2 and L3

Course Outcomes:

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

- List, define and explain all static and dynamic characteristic of instrument and measurement systems.
- Discuss the different types of errors and their interpretation.
- Discuss and analyze the dynamic response of instrument and measurement systems in time domain and frequency domain.

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:

Textbook:

1. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.

Reference Books:

1. Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012
2. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112107242
- https://www.youtube.com/watch?v=5eOgWyfXjr8
- https://www.youtube.com/watch?v=Hlvbr5DCEfM

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

- List the characteristics / specifications of all instruments available in the labs.
- Verifying the characteristics / specifications of all instruments available in the labs.
- Observe and analyze the errors encountered during the conduction of lab experiments
- Study the dynamic response of the instruments available in the labs

NETWORK ANALYSIS			
Course Code (AEC-III Theory)	**21EI/BM382**	CIE Marks	50
Teaching Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

Course objectives: This course will enable students to:

1. Apply mesh and nodal techniques to solve an electrical network.
2. Solve different problems related to Electrical circuits using Network Theorems and Two port network.
3. Familiarize yourself with the use of Laplace transforms to solve network problems.
4. Be familiar with the most fundamental Graph theory topics and results.

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Show Video/animation films to explain functioning of various concepts.
- Encourage collaborative (Group) Learning in the class .
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
- 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.
- Topics will be introduced in a multiple representation.
- Show the different ways to solve the same problem and encourage the students to come up withtheir own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.
- Give Programming Assignments.

Module-1

Basic concepts

Types of Sources, Loop analysis, Nodal analysis with independent DC and AC Excitations.
(Textbook 1: 2.3, 4.1, 4.2, 4.3, 4.4, 10.6)

Teaching- Learning Process	Chalk and Talk, YouTube videos, Demonstrate the concepts using circuits/simulation **RBT Level:** L1, L2, L3

Module-2

Network theorems: Super position theorem, Thevenin's theorem, Norton's Theorem (for DC networks only), Maximum power transfer theorem (for AC & DC networks).
(Textbook 2: 9.2, 9.4, 9.5, 9.7)

Teaching- Learning Process	Chalk and Talk, Demonstrate the concepts using circuits/simulation **RBT Level:** L1, L2, L3

Module-3

Laplace transform and its Applications: Step Ramp, Impulse, Solution of networks using Laplace transform, Initial value and final value theorem
(Textbook 3: 7.1, 7.2, 7.4, 7.7, 8.4)

Teaching-Learning Process	Chalk and Talk, YouTube videos, Demonstrate the concepts using circuits/simulation **RBT Level:** L1, L2, L3

Module-4	
Two port networks: Short- circuit Admittance parameters, Open- circuit Impedance parameters (Textbook 3: 11.1, 11.2, 11.3)	
Teaching-Learning Process	Chalk and Talk, YouTube videos, Demonstrate the concepts using circuits/simulation **RBT Level:** L1, L2, L3
Module-5	
Graph theory: Graph of a network, concepts of: tree & co-tree, incidence matrix, tie-set & cut-set schedules. (Text book 2:8.2,8.3,8.4,8.5,8.6)	
Teaching-Learning Process	Chalk and Talk, YouTube videos, Demonstrate the concepts using circuits/simulation **RBT Level:** L1, L2, L3

Course Outcomes

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

1. Analyse and solve Electric circuit, by applying loop analysis, Nodal analysis and by applying network Theorems
2. Apply Laplace transforms to solve electric networks
3. Apply Two-port network formulation for analyzing electric circuits
4. Apply graph theoretic formulation for the solutions of network equations.

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:

Text Books

1. Engineering circuit analysis, William H Hayt, Jr, Jack E Kemmerly, Steven M Durbin, Mc Graw HillEducation, Indian Edition 8e.
2. Networks and Systems, D Roy Choudhury, New age international Publishers, second edition.
3. Network Analysis, M E Van Valkenburg, Pearson, 3e.

Web links and Video Lectures (e-Resources): • https://nptel.ac.in/courses/108106098 • https://nptel.ac.in/courses/108102042
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Practical implementation of circuits and theorem verification in labs • Simulation of network circuits and theorems • Assignments • Surprise quizzes / tests

DIGITAL DESIGN LAB USING PSPICE/MULTISIM			
Course Code (AEC-III Lab)	**21EI/BM383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

This course will enable the students

To provide hands-on experience in designing and implementing digital circuits. The experiments are designed to give students ability to design, build and implement digital circuits & systems. The Pspice /Multisim simulator helps to evaluate the design of combinational and sequential circuits.

Sl.NO	Experiments
1	Implementation of De Morgan's theorem and SOP/POS expressions using Pspice/Multisim.
2	Implementation of Half Adder, Full Adder, Half Subtractor and Full Subtractor using Pspice/Multisim.
3	Design and implementation of 4-bit Parallel Adder/ Subtractor using IC 7483 using Pspice/Multisim.
4	To realize Binary to Gray code conversion and vice versa using Pspice/Multisim.
5	To realize BCD to excess 3 and vice versa using Pspice/Multisim.
6	To realize Priority encoder and 3:8 Decoder using Pspice/Multisim.
7	To realize One / Two bit comparator using Pspice/Multisim.
8	To realize 4:1 Multiplexer using gates with Pspice/Multisim.
9	To realize 1:8 Demux with Pspice/Multisim.
10	To realize the following flip-flops using NAND Gates (a)T type (b) JK Master slave (c) D type using Pspice/Multisim.
11	To design and implement the 3-bit Mod-N synchronous counters using Pspice/Multisim.
12	To design and implement the Binary ripple counters (up/down) using Pspice/Multisim.

Course outcomes (Course Skill Set):

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

1. Demonstrate the truth table of various expressions and combinational circuits using logic gates.
2. Design various combinational circuits such as adders, subtractors, comparators, multiplexers and code converters.
3. Construct flips-flops and counters.
4. Design and implement synchronous counters..

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is

handling the laboratory session and is made known to students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is **02** hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Digital Logic Applications and Design by John M Yarbrough, Thomson Learning, 2001
2. Digital Principles and Design by Donald D Givone, McGraw Hill, 2002.

AEC LAB USING PSPICE/MULTISIM			
Course Code (AEC-III Lab)	21EI/BM384	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To provide practical exposure to the students on designing, setting up, executing and debuggingvarious electronic circuits using simulation software.
- To give the knowledge and practical exposure on simple applications of analog electronic circuits.

Sl. No	Experiments using Pspice/MultiSIM Software
1	Experiments to realize diode clipping (single, double ended) circuits.
2	Experiments to realize diode clamping (positive, negative) circuits.
3	Experiments to realize Full wave rectifier without filter (and set-up to measure the ripple factor, Vp-p, Vrms, etc.).
4	Design and conduct an experiment on Series Voltage Regulator using Zener diode to determineline/load regulation characteristics.
5	Realize BJT Darlington Emitter follower without bootstrapping and determine the gain, input andoutput impedances (other configurations of emitter follower can also be considered).
6	Experiment to realize Input and Output characteristics of BJT Common emitter configuration and evaluation of parameters.
7	Experiments to realize Transfer and drain characteristics of a MOSFET.
8	Set-up and study the working of class A power amplifier and calculate the efficiency
9	Set up and study the response of a two stage RC-coupled amplifier and calculate gain and bandwidth
10	To design and test the Common emitter-Common base cascade amplifier to determine the gain and bandwidth from its frequency response.
11	Design and set-up the Wein bridge oscillator and determine the frequency of oscillation
12	Design and set-up the oscillator circuits (Hartley/ Colpitts using BJT/FET) and determine thefrequency of oscillation

Course outcomes (Course Skill Set):

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

1. Explain the circuit schematic and its working.
2. Study the characteristics of different electronic devices.
3. Design and test simple electronic circuits as per the specifications using discrete electronic components.
4. Compute the parameters from the characteristics of active devices.
5. Familiarize with EDA software which can be used for electronic circuit simulation.

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 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners).

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is **02** hours.

Rubrics suggested in Annexure-II of Regulation book.

Suggested Learning Resources:

1. David A Bell, "Fundamentals of Electronic Devices and Circuits Lab Manual, 5th Edition, 2009, Oxford University Press.
2. Muhammed H Rashid, "Introduction to Pspice using Or CAD for circuits and electronics", 3^{rd} Edition, Prentice Hall, 2003.

ADDITIONAL MATHEMATICS – I			
Course Code (NCMC)	21MATDIP31	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	--
Total Hours of Pedagogy	40	Total Marks	100
Credits	--	Exam Hours	--

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2021 - 22)

IV Semester

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS			
Module – 1			

Module – 2	
Module – 3	
Module – 4	
Module – 5	
Course Outcomes	
ASSESSMENT PATTERN (BOTH CIE AND SIE)	

EMBEDDED CONTROLLERS			
Course Code (IPCC)	**21EI/BM42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course will enable students to:

- Understand the difference between a Microprocessor and a Microcontroller and embedded microcontrollers and different architectures. Familiarize the basic architecture of 8051 microcontroller.
- Learn instructions and Program 8051microcontroller using Assembly Level Language, addressing modes, directives.
- Learn basics of C for 8051 and C program for 8051
- 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. Understand the interrupt system of 8051 and the use of interrupts

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.
- Give Programming Assignments.

MODULE-1

Introduction: Microprocessor and Microcontroller, Microprocessor survey, RISC and CISC CPU Architecture. Harvard and Von-Neumann CPU Architecture. 8051 Microcontroller Architecture. Pin functions description. Input/ Output port pins and circuits. Internal and External memory Architecture. 8051 Reg. banks and stack. 8051 flag bits and PSW Register. Special function Registers. Timer /Counter, Serial data input/ output. Interrupts. program counter and ROM space in the 8051.

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**

MODULE-2

Addressing modes directives instruction set of 8051 Microcontroller. 8051 data types and directives, Immediate and Register addressing modes. Accessing memory using various addressing modes. Bit addressing for I/O and RAM. 8051 data types and directives. Jump Loop and CALL Instructions Arithmetic and Logic Instructions and programming. I/O port programming. Assembly Language program various instruction set.

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**

MODULE-3

8051 programming in C. Advantages of programming 8051 in C. Data types and time delay in 8051 C. I/o programming. Bit addressable programming. Logic operations. data conversion programs. Accessing Code ROM Space, data serialization using 8051 C.

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**

MODULE-4

Timer/ Counter, Serial communication in 8051. Programming 8051 timer/ counter, programming timer 0 and 1 in 8051 C. Basics of serial communication. 8051 connections to RS-232. 8051 serial port programming in assembly and C.

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**
MODULE 5	
Interfacing 8051: Interfacing of 8051 with ADC-0804, DAC, LCD , Stepper motor and keyboard and their 8051 Assembly and C language interfacing programming. **Interrupts:** Programming Timer Interrupts, External hardware Interrupts and serial communication Interrupts. Interrupts priority & Interrupt programming in C.	
Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,L3)**

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Program for 8 bit and 16 bit addition. square root of 8 bit and 16 bit for 8051 microcontroller
2	Program using 8051 in Block, Move, Exchange.
3	Program in sorting, finding largest and smallest element in an array
4	Counters - For Hex and BCD up/ down count.
5	Boolean and Logical Instructions. (Bit Manipulation).
6	Code Conversions ---> ASCII to Decimal, Decimal to ASCII, BCD to ASCII
7	Subroutines using CALL and RETURN instructions
8	Programs to generate delay, programs using serial port and on chip timer/ counter.
9	Stepper motor Interface to 8051 Microcontroller with C Program
10	DC Motor Interface to 8051 Microcontroller with C Program
11	DAC Interface for to generate sine wave, square wave, triangular wave, Ramp wave through 8051Microcontroller with C Program.
12	Keyboard Interfacing

Course outcomes (Course Skill Set):

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

1. Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.
2. Develop 8051 Assembly level programs using 8051 instruction set.
3. Develop 8051 Assembly / C language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port.
4. Develop 8051 Assembly / C language programs to generate square wave on 8051 I/O port pin using interrupt and C Program to send & receive serial data using 8051 serial port. Interface various peripheral devices to 8051 using 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**.

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

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 Books

1. The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005

Web links and Video Lectures (e-Resources): • VTU e-shikshana programmes • VTU Edu-sat programmes • https://nptel.ac.in/courses/106105193 • https://nptel.ac.in/courses/108105102
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Developing programming skills by carrying out mini projects. • Quizzes • Assignments • Seminars

JAVA PROGRAMMING			
Course Code (IPCC)	**21EI/BM43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- To Understand object oriented programming concepts, and apply them in solving problems.
- To Understand Set up Java JDK environment to create, debug and run simple Java programs.
- To Understand Introduce the concepts of exception handling and multithreading.
- To Understand Introduce the design of Graphical User Interface using applets and swing controls.

Teaching-Learning Process (General Instructions)

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop student's theoretical and programming skills.
2. State the need for learning Programming with 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-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).
- As a model solution of some exercises (post-lecture activity).

MODULE-1

Object Oriented Programming and JAVA: Object Oriented Paradigm, basic concepts, benefits and applications of OOPs. JAVA history and features, How java differs from C and C++, JAVA and Internet, JAVA and World Wide Web, Web browsers, JAVA support systems, JAVA environment. JAVA program structure, Tokens, Statements, JAVA Virtual Machine.

Overview of JAVA Language: Simple Java Program, Math functions, An application with two classes, Java program structure, Java Tokens, Java Statement, Implementing a Java Program, Java Virtual Machines, Command and Line Arguments, Programming Style.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-2

Constants, Variables, Data Types: Declaration and scope of Variables, Symbolic constants, Type Casting, Standard Default values.

Operators and Expression: Arithmetic, Relational, Logical, Assignment, Increment, Decrement, Conditional, Bitwise, Special Operators, Arithmetic Expressions, Evaluation, Procedure of Operators, Type Conversion in Expressions, Mathematical functions.

Decision Making, Branching and Looping: If Statement, If….Else statement, Nesting of statements, Switch Statement, Operator, While Statement, Do statement, For statement, Jump in Loops.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-3

Classes, Objects and Methods: Class definition and declaration, Creating Object, Accessing Class Members, Constructors, Methods Overloading, Static Members, Nesting Methods, Inheritance, Overriding Methods, Final Variables and Methods, Final Classes, Finalizer Methods, Abstract Methods and Classes, Visibility Control.

Arrays, Strings and Vectors: One and two dimensional arrays, Strings, Vectors, Wrapper Classes

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-4	
Interfaces: Definition, Extending and Implementing Interfaces, Accessing Interface variables. **Packages:** JAVA API Packages, Using System packages, Naming conventions, Creating, Accessing and Using a package, Adding a class to a Package, Hiding Classes. **Multithreaded Programming :** Creating and Extending Thread Class, Stopping, Blocking and Life Cycle of Thread, Using Thread Methods, Thread Exceptions and Priority, Synchronization, Implementing runnable Interface.	
Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE 5	
Applet Programming: Introduction, How Applets Differ from Applications, Preparing to write Applets, Building Applet Code, Applet Life Cycle, Creating an Executable Applet , Designing a Web Page, Applet Tag, Adding Applet to HTML File, Running the Applet, Passing Parameters to Applets, Aligning the Display, More about HTML Tags, Displaying Numerical Values, Getting Input from the User, Event Handling.	
Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

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

Sl.NO	Experiments
1	a. Write a java Program to illustrate the creation of variables of basic types and effect of type conversions. b. Write a java Program that display the roots of a quadratic equation $ax^2+bx=0$. Calculate the discriminate D and based on value of D, describe the nature of root.
2	a. Write a java program to demonstrate creation and accessing of objects and methods. b. Write a java program to illustrate use of constructor overloading and method overloading.
3	a. Write a java Program to demonstrate the concept of single Inheritance. b. Write a java program to implement multi level Inheritance.
4	Write a simple Program on Java to illustrate the implementation of the concept of multiple inheritance using interfaces.
5	a. Write a java program to demonstrate String Methods used for manipulating strings like accessing, inserting, modifying and appending. b. Write a java program to illustrate use of most commonly used wrapper class methods.
6	Write a Java program to implement the concept of importing classes from user defined package and creating packages.
7	Write a Java program using Synchronized Threads, which demonstrates Producer Consumer concept.
8	a. Write a Java program for creation of Java Built-in Exceptions. b. Write a Java program for creation of User Defined Exceptions.
9	Complete the following: i. Create a package named shape. ii. Create some classes in the package representing some common shapes like Square, Triangle, and Circle. **iii.** Import and compile these classes in other program
10	a. Write a Java program to copy bytes from one file to another using File Input Stream and File Output Stream. b. Write a Java program to illustrate the process of file concatenation and buffering.
11	Write a Java applet program, which handles keyboard event.
12	Write an Applet that displays ―Hello World‖ (Background color-black, text color-blue and your name in the status window.)
13	Write a Java Program to demonstrate Mouse events.
14	Write programs for using Graphics class i. To display basic shapes and fill them ii. Draw different items using basic shapes set background and foreground colors.

Course outcomes (Course Skill Set):

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

1. To Understand OOPs concepts and basics of Java programming.
2. To Create Java programs using inheritance and polymorphism.
3. To Implement error-handling techniques using exception handling and multithreading.
4. To Develop GUI using Applets and Swing components.
5. Analyze, design and develop solutions to real-world problems applying OOPs concepts through JAVA.

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

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. E.Balaguruswamy – Programming with JAVA – A Primer – 5th Edition, McGraw Hill
2. Herbert Schildt, Java the Complete Reference, 7th Edition, Tata McGraw Hill, 2007.
3. Object oriented programming in TURBO C++ - Robert Lafore, Galgotia Publications, 2002.
4. Mahesh Bhave and Sunil Patekar, "Programming with Java", First Edition, PearsonEducation, 2008.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program
- https://www.w3schools.com/java/
- https://www.youtube.com/watch?v=CFD9EFcNZTQ
- https://www.youtube.com/watch?v=grEKMHGYyns

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

- Programming skills to solve real world problems.
- Quizzes
- Assignments
- Seminars

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS			
Course Code (PCC)	**21EI/BM44**	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: This course will enable the students to

- Define and describe Op Amp, basic concepts, characteristics and specifications
- Gain knowledge about Linear and nonlinear applications of Op-amp.
- Design and develop circuits like, amplifiers, filters, Timers to meet industrial requirements.
- Get a firm grasp of basic principles of op-amp.

Teaching-Learning Process (General Instructions)

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

1.Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2.Show Video/animation films to explain evolution of communication technologies.
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.Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
7.Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.

Module-1

Module -1

Introduction to Operational Amplifiers: Introduction, Block schematic of an Op-amp, Power supply connections, Characteristics of an Ideal OP-AMP, Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Differential Amplifier, CMRR. (Relevant problems).

Operational Amplifier Characteristics: DC characteristics – Input bias current, Input offset current, Input offset voltage, Total output offset voltage, Thermal drift. AC characteristics – Frequency response, Slew rate, PSRR.

Basic Op-amp applications: Scale changer/Inverter, Summing amplifier: Inverting summing amplifier, Non-inverting Summing amplifier, Subtractor, Instrumentation Amplifier. (Relevant problems).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-2

Operational Amplifier Applications: V – I and I – V converter, Op-amp circuit using diodes, sample and hold circuit, Differentiator and Integrator.

Comparator and waveforms generator: Comparator, Regenerative comparator (Schmitt Trigger), Astable mutivibrator, Monostable multivibrator and Triangular waveform generator. Phase shift oscillator, Wien bridge oscillator. (Relevant problems).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-3

Voltage Regulators: Introduction, Series Op-amp regulator, IC voltage regulators, 723 general purpose regulators, switching regulator.

Active filters: First and Second order LPF, First and Second orders HPF, Band Pass Filters, Band Reject filters. (Design examples).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-4

555 Timer: Description of Functional Diagram, Monostable operation, Applications of Monostable Multivibrator: Frequency Divider & Pulse Width Modulation. Astable operation, Applications of Astable Multivibrator: FSK Generator and Pulse Position Modulation.

Phase Locked Loops: Basic Principles, Analog phase Detector/comparator, Voltage controlled oscillator, PLL

applications: Frequency Multiplication/Division, Frequency translation, FM demodulation	
Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-5

Data Acquisition Systems: Types of instrumentation systems, Components of analog data acquisition system, Digital data acquisition system.

Data Converters:

Digital to Analog Converters: Basic DAC techniques, Weighted Resistor DAC, R – 2R Ladder DAC, DAC 0800 (Data sheet: Features and description only).

Analog to Digital Converters: Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC. ADC 0809 (Data sheet: Features, specifications and description only), DAC/ADC specifications.

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Understand the basic principles and operation of op-amp.
2. Design and develop basic op.amp. circuits
3. Design and develop op.amp. circuits to meet the practical applications
4. Design regulator circuits and filter circuits
5. Understand the operation and applications of 555 timer and PLL
6. Understand data acquisition system components and implement the op-amp circuits in electronic gadgets.

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)**

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:

Text Books

1. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5)
2. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3)
3. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5)

Reference Books:

1. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin & Fred. F. Driscoll, PHI/Pearson, 2006
2. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001
3. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

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

- Quizzes
- Surprise Tests
- Assignments
- Seminars

IV Semester

BIOLOGY FOR ENGINEERS			
Course Code (AEC)	21BE45	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	25 Hours	Total Marks	100
Credits	02	Exam Hours	02

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS LAB			
Course Code (PCC Lab)	**21EI/BM L46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives: This laboratory course enables students to

- Understand the working of opamp. as amplifier, inverter and scale changer
- Realize and test amplifier and oscillator circuits for the given specifications
- Implement filtering circuits for signal processing applications
- Realize the opamp circuits for the applications such as DAC, implement mathematical functions

Sl.NO	Experiments
1	Design and implement Inverting Amplifier, Non-Inverting Amplifier and Voltage Follower
2	Realize Full wave Precision rectifier using op.amp.
3	Design and implement Butterworth Second order Low-pass filter
4	Design and implement Butterworth Second order High-pass filter
5	To design and implement RC Phase shift oscillator
6	To design and implement Wein Bridge oscillator
7	To design and implement Astable Multivibrator using 555 timer
8	To realize Sample and Hold circuit using discrete components
9	To design and implement 4 bit R-2R DAC using discrete components
10	Implement 8-bit DAC using IC DAC 0800 IC
11	Implement 8-bit ADC using ADC 0809 IC
12	Implement 3 bit Flash ADC using ICs

Course outcomes (Course Skill Set):

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

1. Sketch/draw circuit schematics, construct circuits on breadboards, analyze and troubleshoot circuits containing Op-amps, resistors, diodes, capacitors and independent sources.
2. Memorize and reproduce the manufacturer's data sheets of IC 555 timer, IC μa741 op-amp and data converters like IC ADC 0800 and IC DAC 0809.
3. Design and evaluate analog integrated circuits like Amplifiers, Oscillators, Active filters, Precision Rectifiers and Voltage level detectors, and compare the experimental results with theoretical values.
4. Demonstrate and analyze the working of Sample-Hold, Programmable gain amplifier and Analog Multiplexer circuits in data acquisition system.
5. Design and evaluate different resolution data converters using discrete components and ICs.

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. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International.
2. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI
3. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.
4. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin & Fred. F. Driscoll, PHI/Pearson, 2006
5. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001
6. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

SAMSKRUTIKA KANNADA			
Course Code (HSMC)	21KSK37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

BALAKE KANNADA			
Course Code (HSMC)	21KBK37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS			
Course Code (HSMC)	21CIP37/47	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

PROGRAMMING IN MATLAB			
Course Code (AEC-IV Lab)	**21EI/BM481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

1. Preparation: To prepare students with fundamental knowledge/ overview in the field of basic signal. Processing computations.

2. Core Competence: To equip students with a basic foundation in mathematics fundamentals required for comprehending the operation and application of signal processing.

3. Professionalism & Learning Environment: To inculcate in students an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career..

Sl.NO	Experiments
1	Programs on basic algebra functions.
2	Programs on basic operations of vector.
3	Programs on basic operations of matrix.
4	Program to generate discrete waveforms.
5	Program to perform basic operation on signals.
6	Program to perform convolution of two given sequences.
7	Program to perform correlation of two given sequences.
8	Programs to plot different types of graphs
	Demonstration Experiments (For CIE)
9	Verify sampling theorem.
10	Demonstrate Amplitude Modulation

Course outcomes (Course Skill Set):

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

1. Understand the basics of Linear Algebra
2. Analyse different types of signals and systems
3. Analyse the properties of discrete time signals & 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 course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is

handling the laboratory session and is made known to students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is **02** hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Digital Signal Processing Using MATLAB, John G Proakis and Vinay K Ingle, Cengage Learning, 2011

VIRTUAL INSTRUMENTATION USING LABVIEW			
Course Code (AEC-IV Lab)	**21EI482**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To Understand the programming techniques of virtual instrumentation using lab view.
- To perform basic arithmetic and Boolean operation
- To perform looping

Sl.NO	Experiments
1	BASIC ARITHMETIC OPERATIONS
2	BOOLEAN OPERATIONS
3	SUM OF 'n' NUMBERS USING 'FOR' LOOP
4	FACTORIAL OF A GIVEN NUMBER USING FOR LOOP
5	SUM OF 'n' NATURAL NUMBERS USING WHILE LOOP
6	FACTORIAL OF A GIVE NUMBER USING WHILE LOOP
7	SORTING EVEN NUMBERS USING WHILE LOOP IN AN ARRAY
8	ARRAY MAXIMUM AND MINIMUM
9	BUNDLE AND UNBUNDLE CLUSTER
10	FLAT AND STACKED SEQUENCE
11	APPLICATION USING FORMULA NODE
12	MEDIAN FILTER
	Demonstration Experiments (For CIE)
13	DISCRETE COSINE TRANSFORM
14	CONVOLUTION OF TWO SIGNALS
15	WINDOWING TECHNIQUE
16	INSTRUMENTATION OF AN AMPLIFIER TO ACQUIRE AN ECG SIGNAL

Course outcomes (Course Skill Set):

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

- Able to develop the virtual instrumentation using lab view.
- Able to execute basic arithmetic and Boolean operation
- Able to perform looping operations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is **02** hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- Virtual Instrumentation using labview, Jovitha Jerome PHI learning Private Limited, New Delhi**.**

SIGNAL CONDITIONING LAB USING PSPICE / MULTISIM			
Course Code (AEC-IV Lab)	**21EI/BM483**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To learn the linear and non-linear applications of operational amplifiers
- To understand the fundamentals of ADC and DAC conversion techniques
- To use Multisim /Pspice software for circuit design .

Sl.No	Experiments using Pspice / MultiSIM Every experiment has to be designed, circuit to be drawn / constructed and executed in thespecified software. Results are also to be noted and inferred.
	Note: Standard design procedure to be adopted.
1	To realize using op-amp an Inverting Amplifier and Non-Inverting Amplifier
2	To realize using op-amps i) Summing Amplifier ii)Difference amplifier
3	To realize using op-amps an Instrumentation Amplifier
4	To realize using op-amps i) Differentiator ii)Integrator
5	To realize using op-amps a Full wave Precision Rectifier
6	To realize using op-amp an Inverting Schmitt Trigger
7	To design and implement using op-amps • Butterworth I & II order Low Pass Filter • Butterworth I & II order High Pass Filter
8	To design and implement using op-amp an RC Phase Shift Oscillator
9	To realize using op-amp an Astable Multivibrator
10	To design and implement Mono-stable Multivibrator using 555 timer
11	To design and implement an 8- bit Successive approximation Analog to Digital converter.
12	To design and implement 4 - bit R-2R Digital to Analog Converter

Course outcomes (Course Skill Set):

After studying this course, students will be able to;

1. Sketch/draw circuit schematics, construct circuits, analyze and troubleshoot circuits containingop-amps, resistors, diodes, capacitors and independent sources.
2. Relate to the manufacturer's data sheets of IC 555 timer and IC µa741 op-amp.
3. Realize and verify the operation of analog integrated circuits like Amplifiers, Precision Rectifiers, Oscillators using Pspice.
4. Analyze the performance of filters, multivibrators, ADC and DAC using Pspice.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is **02** hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, 4th Edition, Pearson Education, 2018.

UNIVERSAL HUMAN VALUES			
Course Code (UHV)	21UH49	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

INTER/INTRA INSTITUTIONAL INTERNSHIP			
Course Code (INT)	21INT49	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	--	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	02	Exam Hours	03

ADDITIONAL MATHEMATICS – II			
Course Code (NCMC)	21MATDIP41	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	--
Total Hours of Pedagogy	40	Total Marks	100
Credits	--	Exam Hours	--

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the Academic Year 2021 - 22)

V Semester

PROCESS INSTRUMENTATION			
Course Code (PCC)	**21EI51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives:

- To impart the principle, design and working of transducers/sensors for the measurement of flow, force & torque, pressure, sound, speed, thickness, level, density, viscosity, humidity and moisture.
- To provide the basic knowledge in selection of appropriate transducers/sensors for the measurement of above process parameters based on their specifications, advantages and limitations.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Introduce the topics in a manifold representation.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Flow Measurement: Introduction, Classification of Flow Meters, Head type flow meters – Orifice meter and Venturi tube, Rotameter, Electromagnetic Flow Meter, Ultrasonic flow meter, Laser anemometer, Rotor torque mass flow meter.

Measurement of Force & Torque: Introduction, Force measuring sensor – Load cells – column type devices, proving rings, cantilever beam, Pressductor, Hydraulic load cell, Electronic weighing system. Torque measurement: Stress type & Deflection type

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2, L3

Module-2

Measurement of Pressure: Introduction, Diaphragms, Other elastic elements, Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device (principle, schematic & working, no derivation), force balance transducer (principle, schematic & working, no analysis), piezoelectric pressure transducer, pressure multiplexer, pressure calibration.

Measurement of Sound, Speed and Thickness: Noise (sound) Sensors – nature of measurement, transducer principle, microphone types, Speed Sensors – tachometer generators, induction type, magnetic type, photoelectric type, Thickness Measurement – contact type and non-contact types.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2, L3

Module-3

Measurement of Level: Capacitance probes (bare & coated capacitance probe), Conductivity probes, Differential

pressure level detector (force balance d/p cell, liquid manometers), Float level devices (atmospheric tanks, rotameter type, mercury float switch, sump level), Optical level switches, Ultrasonic level detector (on-off & continues), Thermal level sensor.

Measurement of Density: Definition & units of density and specific gravity, Liquid density measurement – Ball type, Capacitance type, Displacement type-chain balanced float, Hydrometers, Oscillating Coriolis, Radiation type, Sound velocity type. Gas density measurement – displacement type, electromagnetic suspension type.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2, L3

Module-4

Viscosity Measurement: Definition and units, selection of viscometer, viscometer applications. Laboratory Viscometers – Capillary, capillary extrusion, Efflux cup (Saybolt viscometer), Falling ball, Rotational viscometer, Cone & plate viscometer. Industrial Viscometers - differential pressure continuous capillary viscometer, single and two float viscometer, cone and plate plastometer, vibrating reed viscometer.

Turbidity: Definition, transmission type turbidity meter, light scattering turbidity meter.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2, L3

Module-5

Humidity Measurement: Definition and terminologies, dry and wet bulb psychrometers (Sling psychrometer), hair hygrometers, thin film capacitance humidity sensor, dew-point hygrometers, electrolytic hygrometers.

Moisture Measurement: Definition and terminologies. Measurement of moisture in gases and liquids – Electrolytic hygrometer, capacitance hygrometer, impendence hygrometer, piezoelectric hygrometer, infrared absorption hygrometer. Measurement of moisture in solids – Nuclear moisture gauge, infrared reflection moisture gauge, capacitance moisture gauge..

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom. RBT Level: L1, L2, L3

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

1. Discuss the principle, construction and working of transducers for the measurement of flow and force & torque.
2. Explain the principle, construction and working of transducers for the measurement of pressure, sound, speed and thickness.
3. Illustrate the principle, construction and working of transducers for the measurement of level and density
4. Discuss the principle, construction and working of transducers for the measurement of viscosity and turbidity.
5. Explain the principle, construction and working of transducers for the measurement of humidity and moisture.

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)**

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:

Textbooks:

1. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 1 & Module 2 – Measurement of Pressure).
2. Process Measurement Instrument Engineers Handbook- Bela G. Liptak, Revised Edition, Chilton Book Company, 1982. [Module 2- Measurement of Sound, Speed and Thickness, Module 3 and 4]
3. Industrial Instrumentation – K. Krishnaswamy and S. Vijayachitra, New Age International Pub., 2005. [Module 5]

Reference Books:

1. Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009.
2. Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007.
3. Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009.
4. Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105064
- https://onlinecourses.nptel.ac.in/noc21_ch26/preview
- https://www.youtube.com/watch?v=1uPTyjxZzyo
- https://nptel.ac.in/courses/103105130

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

- Explore the use of different type of instruments and transducers being used in the real world situation.
- Demonstration of instruments and transducers in the laboratory.
- Develop mini projects using instruments and transducers.

FUNDAMENTALS OF SIGNALS AND DSP			
Course Code (IPCC)	**21EI/BM52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

1. **Preparation:** To prepare students with fundamental knowledge/ overview in the field of Signal Processing
2. **Core Competence:** To equip students with a basic foundation of Signal Processing by delivering the basics of Linear Transformations, the mathematical description of discrete time signals and systems, analyzing the signals in time domain using convolution sum, classifying signals into different categories based on their properties, analyzing Linear Time Invariant (LTI) systems in time and transform domains Discrete Fourier Transforms & their properties, design of filters and overview of digital signal processors

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes. Show Video/animation films to explain the different types of Signals & Signal Processing.
- Encourage collaborative (Group) Learning in the class.
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
- 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.
- Topics will be introduced in a multiple representation. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.
- Give Programming Assignments.

MODULE-1

Introduction and Classification of signals: Definition of signal and systems with examples, Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions

Basic Operations on signals: Amplitude scaling, addition, multiplication, time scaling, time shift and time reversal. Expression of triangular, rectangular and other waveforms in terms of elementary signals.

System Classification and properties: Linear-nonlinear, Time variant -invariant, causal-noncausal, static-dynamic, stable-unstable, invertible.

(Text 1) [Only for Discrete Signals & Systems]

Teaching-Learning Process	Chalk and Talk, YouTube videos, Flipped Class Technique, Programming assignments **RBT Level:** L1, L2, L3

MODULE-2

Time domain representation of LTI System: Impulse response, convolution sum. Computation of convolution sum using graphical method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular.

LTI system Properties in terms of impulse response: System interconnection, Memory less, Causal, Stable, Invertible and Deconvolution and step response

(Text 1) [Only for Discrete Signals & Systems]

Teaching-Learning Process	Chalk and Talk, YouTube videos, Flipped Class Technique, Programming assignments **RBT Level:** L1, L2, L3

MODULE-3

Discrete Fourier Transforms (DFT): Frequency domain sampling and Reconstruction of Discrete Time Signals, The Discrete Fourier Transform, DFT as a linear transformation, Properties of the DFT: Periodicity, Linearity and Symmetry properties, Fast-Fourier-Transform (FFT) algorithms: Efficient: Radix-2 FFT algorithms for the computation of DFT decimation in time.

[Text 2]

Teaching-Learning Process	Chalk and Talk, YouTube videos, Programming assignments **RBT Level:** L1, L2, L3

MODULE-4

Filters: **IIR Filters:** Low-pass filter specifications, IIR filter Design by Impulse Invariance & Bilinear Techniques, Design of Digital IIR filter by Butterworth approach, Examples. Magnitude response of lowpass filters (Theoretical concept only). **FIR Filters:** Design of FIR filters – Symmetric and Antisymmetric FIR filters, Design of Linear phase FIR filters by Rectangular Hamming & Hanning windows. Summary of window function characteristics (window shape, transition bandwidth, stop band attenuation, etc.). Implementation of FIR filters by direct form and Single-stage lattice structure only. **[Text 2]**	
Teaching-Learning Process	Chalk and Talk, YouTube videos, Programming assignments **RBT Level:** L1, L2, L3
MODULE 5	
Multirate Digital Signal Processing & Adaptive Filters: Introduction, Decimation Process, Interpolation Process, Digital Filter Bank, Adaptive Filters, LMS adaptive algorithm, Applications, Features & Architectural of TMS320C54XX processor. **[Text 3]**	
Teaching-Learning Process	Chalk and Talk, YouTube videos, Programming assignments **RBT Level:** L1, L2, L3

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Program to generate discrete waveforms and basic operations on signals.
2	Program to perform convolution of two given sequences: Linear and Circular
3	Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum.
4	Computation of linear convolution of two sequences using DFT and IDFT.
5	Computation of circular convolution of two given sequences using DFT and IDFT
6	Implementation of IIR (Butterworth) low pass filter.
7	Implementation of IIR (Butterworth) high pass filter.
8	Design and implementation of FIR low pass filter to meet given specifications: Hamming, Hanning and Rectangular window.
	Demonstration Experiments for CIE
9	Implementation of FIR high pass filter to meet given specifications: Hamming, Hanning and Rectangular window.
10	Demonstrate sampling theorem
11	Verification of Parseval's theorem
12	Verification of Amplitude Modulation

Course outcomes (Course Skill Set):

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

1. Analyse different types of signals and systems, Analyse the properties of discrete time signals & systems
2. Determine response of LTI systems using time domain and DFT techniques.
3. Compute DFT using FFT algorithms
4. Design FIR Filters
5. Knowledge of DSP processor.

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 scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books:

1. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN9971-51-239-4.
2. Proakis & Manolakis, "Digital Signal Processing - Principles Algorithms & Applications", 4th Edition,

Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
3. Avtar Singh and S.Srinivasan "Digital Signal Processing-Implementations Using DSP Microprocessors with Examples from TMS320C54xx", Thamson / Brooks Cole Publishers, 2003

Reference Books:

1. Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013,
2. Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI, 2003.
3. D Ganesh Rao and Vineeth P Gejji, "Digital Signal Processing" Cengage India Private Limited, 2017, ISBN: 9386858231
4. V.Udayashankara, "Modern Digital Signal Processing", Third Edition, PHI 2016

Web links and Video Lectures (e-Resources):

- By Prof. S. C. Dutta Roy, IIT Delhi https://nptel.ac.in/courses/117102060
- https://nptel.ac.in/courses/108104100
- https://onlinecourses.nptel.ac.in/noc21_ee20/preview

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

- Programming Assignments / Mini Projects can be given to improve programming skills

ARM PROCESSOR			
Course Code (PCC)	**21EI53**	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:

- Understand the basic design and architecture of arm processor
- To learn the ARM instruction for assembly and **c** program
- To learn the thumb instruction for assembly and **c** program and **c** basics for ARM
- Understand the usage of exceptions and interrupts in ARM and operating systems for ARM
- To learn the basic concepts of memory hierarchy, usage of cache memory and memory management

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods like ppt presentation through LCD may be adopted to develop the outcomes.
- Show Video/animation films to explain evolution of arm processor development technologies.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
- 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.
- Show the different ways to solve the same program task and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

ARM Embedded Systems: Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware - AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications.

ARM Processor Fundamentals: ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions. Nomenclature. ARM processor families.

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1, L2

Module-2

Introduction to the ARM Instruction set: Introduction, Data processing instructions, Branch instructions, Load - Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, ARMv5E extensions, Conditional Execution

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1, L2

Module-3

Introduction to the THUMB instruction set: Introduction, THUMB register usage, ARM – THUMB interworking, Other Branch instructions, Data processing instructions, single-register and multiple-register load-store instructions, Stack instructions, Software interrupt instructions. **Efficient C Programming:** Overview of C Compilers and optimization, Basic C Data types, C looping Structures Register allocation, Function calls.

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1, L2

Module-4

Exception and Interrupt Handling: Exception Handling-ARM Processor Exceptions and Modes, Vector Table, Exception Priorities, Link Register Offset, Interrupts- Interrupt Latency, Basic Interrupt Stack design and implementation, Interrupt Handling Scheme- Non nested Interrupt Handler, Nested Interrupt Handler, Reentrant Interrupt Handler, Prioritized Simple Interrupt Handler, **Embedded Operating Systems**: Fundamental Components, SLOS Directory Layout, Initialization, Interrupts and Exceptions handling, scheduler, Context Switch, Device Driver Framework.

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1, L2

Module-5	
CACHES: The memory Hierarchy and caches memory-caches and memory management units, Cache Architecture basic architecture of caches memory, basic operation of cache controller, the relationship between cache and main memory. **Memory Management Units**: Moving from an MPU to an MMU, Virtual memory Working-Defining regions using pagers, multitasking and the MMU, Memory organization in a virtual memory system, page tables Translational look aside buffer.	
Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1, L2

Course outcome (Course Skill Set)

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

1. After studying this course, students will be able to Depict the organization, architecture, bus technology, memory and operation of the ARM microprocessors
2. Employ the knowledge of Instruction set of ARM processors to develop basic Assembly Language Programs
3. Recognize the importance of the Thumb mode of operation of ARM processors and develop C programs for ARM processors
4. Describe the techniques involved in Exception and Interrupt handling in ARM Processors and understand the fundamental concepts of Embedded Operating Systems
5. Develop embedded C programs to interact with Built in Peripherals for hardware programs
6. Design, analyze and write programs using Keil software

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)**

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:

Text Books

1. **Andrew N Sloss, Dominic System and Chris Wright," ARM System Developers Guide",** Elsevier, Morgan Kaufman publisher, 1st Edition, 2008/,ISBN:1758608745

Reference Books:

1. David Seal, "ARM Architecture Reference Manual", Addison- Wesley, 2nd Edition, 2009, ISBN:978-0201737196.
2. Furber S, "ARM System on chip Architecture", Addison Wiley, 2nd Edition 2008, ISBN:978- 0201675191
3. Rajkamal, "Embedded System", Tata McGraw-Hill Publishers, 2nd Edition, 2008, ISBN:

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programmes
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/117106111
- https://www.youtube.com/watch?v=4VRtujwa_b8
- https://www.digimat.in/nptel/courses/video/117106111/L30.html

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

- Quizzes
- Programming Assignments
- Seminars
- Development of mini projects using ARM processor.

CONTROL SYSTEMS			
Course Code (PCC)	**21EI54**	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: This course will enable the students to

- Understand the basic concepts & mathematical modeling of systems
- Draw block diagram & reduction for a given system
- Obtain Transfer functions by reduction and Signal Flow graph techniques.
- Analyze the system response in time and frequency domain
- Understand and Design of control systems using state space analysis

Teaching-Learning Process (General Instructions)

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

- Always start every class hour with preamble of what was covered in previous class and what would be discussed in the present class.
- Encourage group discussion and arrange debate on certain topics.
- Solve problems by considering some real time examples.
- After solving some numerical examples, Invite students to solve some other numerical problems directly on to the black board. So that one will be boosting students confidence level.
- At the end of each topics give sufficient assignments covering all types of possible numerical problems which might have appeared in various other universities question papers.
- Arrange seminars by the students on certain intriguing topics relevant to syllabus by the students.

Module-1

Modeling of Systems and Block diagram: Introduction to Control Systems, Types of Control Systems, with examples. Concept of mathematical modeling of physical systems- Mechanical, Translational (Mechanical accelerometer, systems excluded), and Rotational systems, Analogous systems based on force voltage analogy and force current analogy. Introduction to Block diagram algebra. Numerical problems on all topics.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-2

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

Time response analysis: Introduction. Standard test signals, response of first order & second order systems for unit step input. Steady state errors & Error constants. Numerical problems on all topics.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-3	
Concepts of stability: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion. **The Root Locus Technique**: Introduction. Root locus concepts. Construction of root loci. Stability analysis using Root locus Technique, Numerical problems on all topics.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3
Module-4	
Frequency domain Analysis: Introduction to frequency domain analysis, Correlation between time & frequency response, Bode plots. Numerical problems on all topics. **Polar Plot**: Introduction to Polar plot and Nyquist plots, Nyquist stability criterion. Stability analysis using Polar plot. Numerical problems on all topics.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3
Module-5	
State space Analysis: Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Course outcome (Course Skill Set)

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

- Apply modeling knowledge in implementation physical systems.
- Perform the reduction of block diagram & analyze using Signal flow graph.
- Comment on performance of a system by evaluating various parameters.
- Model a system by applying the concept of State Space 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**)

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)**

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. "Control Systems Engineering", I. J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.
2. "Modern Control Engineering ", K.Ogata, Pearson Education Asia/ PHI, 4thEdition, 2002.
3. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8thEdition, 2008.
4. "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.
5. "Feedback Control Systems". S.C. Goyal and U.A. Bakshi, Technical Publications, Pune.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/107106081

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

- Quizzes
- Assignment
- Seminars

ARM PROCESSOR LAB

Course Code (PCC Lab)	**21EIL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

1 Student will learn all ARM and THUMB instructions by learning assembly language programming
2 Student will learn the concept of learning interfacing of arm to DAC, STEPPER MOTOR DC MOTOR and display system.
3 Student will understand the concept of key board interface led on/off control and seven segment display as study experiments.

NOTE: Conduct the following experiments by writing Assembly Language Program (ALP) using ARM Cortex M3 Registers LPC2148 AND LPC1768 for hardware programs using an evaluation board/simulator and the required software tool.

Sl.NO	Experiments
1	Write an ALP to multiply two 16- bit binary numbers.
2	Write an ALP to find the sum of first 10 integer numbers.
3	Write an ALP to find factorial of a number.
4	Write an ALP to add an array of 16- bit numbers and store the 32- bit result in internal RAM
5	Write an ALP to add two 64- bit numbers.
6	Write an ALP to find the square of a number (1 to 10) using look-up table.
7	Write an ALP to find the largest/smallest number in an array of 32 numbers.
8	Write an ALP to arrange a series of 32 bit numbers in ascending/descending order

9	Write an ALP to count the number of ones and zeros in two consecutive memory locations.
10	Interface with lpc1768 ARM to Display "Hello World" message using Internal UART.
11	Interface and Control a DC Motor.
12	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction
13	Interface a DAC and generate Triangular and Square waveforms.
	Demonstration Experiments (For CIE)
1	Interface a 4x4 keyboard and display the key code on an LCD.
2	Demonstrate the use of an external interrupt to toggle an LED On/Off.
3	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.
4	. Interface a simple Switch and display its status through Relay, Buzzer and LED

Course outcomes (Course Skill Set):

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

- Write ALP for implementation of specific arithmetic or logical operations.
- Write programs to demonstrate functioning of various devices interfaced to ARM processor
- Develop programs for ARM processors to implement real world problems.
- Design and develop mini projects.

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:

- Andrew N Sloss, Dominic System and Chris Wright," ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008/,ISBN:1758608745.
- David Seal, "ARM Architecture Reference Manual", Addison- Wesley, 2nd Edition, 2009, ISBN:978-0201737196

RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS			
Course Code (AEC Theory)	**21XX56**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	02	Exam Hours	02

ENVIRONMENTAL STUDIES			
Course Code (HSMC)	**21CIV57**	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

ARDUINO AND RASPBERRY PI Lab			
Course Code (AEC-V Lab)	**21EI/BM581**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To impart necessary and practical knowledge of components of Internet of Things
- To develop skills required to build real-life IoT based projects

Sl.NO	Experiments
1	i) To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to 'turn ON' LED for 1 sec after every 2 seconds. ii) To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to 'turn ON' LED when push button is pressed or at sensor detection.
2	i) To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings. ii) To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
3	To interface motor using relay with Arduino/Raspberry Pi and write a program to 'turn ON' motor when push button is pressed.
4	To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to Smartphone using Bluetooth.
5	To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from Smartphone using Bluetooth.
6	Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
7	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud
8	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud
9	Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
10	Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.
11	Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
12	Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it

Course outcomes (Course Skill Set):

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

1. Explain the concepts of Internet of Things and its hardware and software components
2. Interface I/O devices, sensors & communication modules
3. Remotely monitor data and control devices
4. Develop real life IoT based projects

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).

- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. https://www.arduino.cc
2. https://www.raspberrypi.org/
3. Course in Internet of Things (IOT) Using Arduino - NIELIT Delhi Centre
4. Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", University Press
5. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
6. Pethuru Raj and Anupama C Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
7. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
8. Adrian McEwen, "Designing the Internet of Things", Wiley
9. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

INTERNET OF THINGS			
Course Code (AEC-V Theory)	**21EI/BM582**	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 Learning Objectives: This course will enable the students to

- Assess the genesis and impact of IoT applications, architectures in real world
- Illustrate diverse methods of deploying smart objects and connect them to network
- Compare different application protocols for IoT
- Infer the role of Security in IoT
- Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Encourage collaborative (Group) Learning in the class.
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Give Programming Assignments

Module-1

Introduction and IoT: Introduction to IoT, IoT Ecosystem, IoT Reference model (Text-1, Chapter-1)

Teaching-Learning Process	Chalk and Talk ,PPT, YouTube videos RBT Level: L1, L2, L3

Module-2

Transducers, Sensors and Actuators: Defining Transducers, Sensors and Actuators, Introduction to Transducers, Introduction to Sensors, Introduction to Actuators, Interfacing Concepts to Embedded Systems, Wireless Sensor Networks and its Technologies. (Text-1, Chapter-2)

Teaching-Learning Process	Chalk and Talk, PPT, YouTube videos RBT Level: L1, L2, L3

Module-3

IoT Protocols: Protocol Classification, MQTT, XMPP, DDS, AMQP, COAP, Representational State Transfer(REST), Comparison of the Protocols. (Text-1, Chapter-3)

Teaching-Learning Process	Chalk and Talk, PPY, YouTube videos RBT Level: L1, L2, L3

Module-4

Domain Specific IoT: Introduction, Home automation, Smart Cities, Environment, Retail, Logistics, Agriculture, Health and Life style. (Text-1, Chapter-4)

Teaching-Learning Process	Chalk and Talk, PPT, YouTube videos RBT Level: L1, L2, L3

Module-5

IoT Platform Design Methodology: Introduction to IoT Platform Design Methodology, Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specification, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Developments.

Teaching-Learning Process	Chalk and Talk, PPT, YouTube videos RBT Level: L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

- Interpret the impact and challenges posed by IoT networks leading to new architectural models.
- Compare and contrast the deployment of smart objects and the technologies to connect them to network
- Appraise the role of IoT protocols for efficient network communication
- Elaborate the need for security in IoT
- Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in industry

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

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

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. Srinivasa K G , Siddesh G M, Hanumantha Raju R, "Internet of Things" Cengage Learning India Pvt Ltd (ISBN : 978-93-86858-95-5).
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals : Networking Technologies, Protocols and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint)(ISBN: 978-9386873743).
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-approach)", 1st Edition, VPT, 2014(ISBN: 978-8173719547)
4. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017(ISBN: 978-9352605224)

Web links and Video Lectures (e-Resources):

- https://www.iotsecurityfoundation.org/iot-security-resources/
- https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/SiteAssets/Pages/Events/2017/Nov_IOT/NBTC%E2%80%93ITU-IoT/Session%201%20IntroIoTMZ-new%20template.pdf
- https://ict.iitk.ac.in/courses/introduction-to-internet-of-things/

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

- To design basic IOT working models

OCTAVE / SCILAB FOR SIGNAL ANALYSIS LAB			
Course Code (AEC-V Lab)	**21EI/BM583**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

1. Preparation: To prepare students with fundamental knowledge/ overview in the field of signals and its analysis using computational method.

2. Core Competence: To equip students with a basic foundation in mathematics fundamentals required for comprehending the operation and application of signal processing.

3. Professionalism & Learning Environment: To inculcate in students an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career.

Sl.NO	Experiments
1	Program to generate discrete waveforms and basic operations on signals.
2	Determine linear convolution of two given sequences. Verify the result using theoretical computations.
3	Determine Circular convolution of two given sequences. Verify the result using theoretical computations.
4	Determine the linear convolution of two given point sequences using FFT algorithm. Verify the result using theoretical computations.
6	Determine the spectrum of the given sequence using FFT. Verify the result using theoretical computations.
7	Test FIR low pass filter using Windowing method (Hamming, Hanning and Rectangular window) for the given order and cut-off frequency.
8	Test IIR Butterworth low pass filter.
	Demonstration Experiments (For CIE)
9	Verify the Sampling theorem.
10	Generation of an AM – Suppressed Carrier Wave & visualization of the time domain and frequency domain plots

Course outcomes (Course Skill Set):

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

- Demonstrate the DSP concepts on signal generation and basic signal operations using Scilab/Octave.
- Design and verify the computation of discrete signals using Scilab/Octave.
- Demonstrate and verify the FFT/DFT algorithm for a given signal using Scilab/Octave.
- Demonstrate programs to evaluate different types of low and high pass FIR filters using Scilab/Octave.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.

- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- Digital Signal Processing Using MATLAB, John G Proakis and Vinay K Ingle, Cengage Learning, 2011.

OPEN PLC / LADDER DIAGRAM PROGRAMMING LAB			
Course Code (AEC-V Lab)	**21EI584**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To learn and understand ladder diagram programming of PLCs.
- Realize the Boolean functions using PLCs ladder diagram instructions.
- Realize the functions of timer / counter operations of PLCs by programming it.

Sl.NO	Experiments
1	To Realize the Boolean functions using NO / NC PLCs functions for AND / OR / NOT / EX-OR / NAND / NOR gates using PLCs ladder diagrams
2	Develop ladder logic to keep lamp on for specific time interval using pulse timer over switch control using PLCs ladder diagrams.
3	To realize functions of Off / On delay timer using PLCs ladder diagrams.
4	To realize functions of Up counter using PLCs ladder diagrams.
5	To realize functions of Down counter using PLCs ladder diagrams.
6	To realize functions of UP - Down counter using PLCs ladder diagrams.
7	To realize functions of Set/ Reset Instructions using PLCs ladder diagrams.
8	To realize functions of Comparison instructions using PLCs ladder diagrams.
	Demonstration Experiments (For CIE)
9	Realization of basic gate functions using PLC. The logic should be solved using ladder diagram. AND (ii)OR (iii)NAND(iv) XOR(v)NOR (vi)Latch and Unlatch of output
10	Study and demonstration of working of different types of Timers and Counters of PLC. The logic should be solved using ladder diagram.
11	Study and demonstration of Bottle Filling Process using PLC. The logic should be solved using ladder diagram.

Course outcomes (Course Skill Set):

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

- Demonstrate Hands on skill set in ladder diagram programming of PLCs.
- Demonstrate ladder diagram programming techniques of Timer / Counters of PLCs.
- Demonstrate the skill set of programming PLCs in demonstration experiments enlisted in the syllabus.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).

- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 02 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- Introduction to Programmable Logic Controllers, Garry Dunning, 3nd edition, Centage Learning.
- Computer based Industrial Control, Krishna Kant, 2nd edition, PHI, 2017 (Modules: 4&5)
- F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2010
- T.A. Hughes, Programmable Controllers, Fourth edition, ISA press, 2005
- http://www.infoplc.net
- https://www/philadelphia.ed

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2021 - 22)

VI Semester

TECHNOLOGICAL INNOVATION MANAGEMENT AND ENTREPRENEURSHIP			
Course Code (HSMC)	**21EI/BM61**	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: This course will enable students to:

- Understand basic skills of Management
- Understand the need for Entrepreneurs and their skills
- Identify the Management functions and Social responsibilities.
- Understand the identification of Business, drafting the Business plan and sources of funding.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- 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.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Management: Nature and Functions of Management – Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession (Selected topics of Chapter 1, Text 1).

Planning: Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning, Types and Steps in Decision Making(Text 1).

Teaching-Learning Process	Chalk and talk method, Power point presentation, Case studies RBT Level:L2,L3

Module-2

Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only), Departmentalization-Process Departmentalization, Purpose Departmentalization ,Committees– Meaning, Types of Committees.

Staffing-Need and Importance**,** Recruitment and Selection Process.

Directing and Controlling: Meaning and Requirements of Effective Direction, Giving Orders; Motivation-Nature of Motivation, Motivation Theories (Maslow's Need-Hierarchy Theory and Herzberg's Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication (Text 1).

Teaching-Learning Process	Chalk and talk method, Power point presentation, Industrial visit RBT Level:L2,L3

Module-3

Leadership-Meaning, Characteristics, Behavioral Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling – Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process (Text 1).
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance (Text 1).

Teaching-Learning Process	Chalk and talk method, Power point presentation, Field visit to understand present scenario. RBT Level:L2,L3,L4

Module-4

Entrepreneurship: Introduction, Evolution of the concept of Entrepreneurship, Entrepreneurship today, Types of Entrepreneurs, Intrapreneurship, Entrepreneurial competencies, Capacity Building for Entrepreneurs.
Identification of Business Opportunities: Introduction, Mobility of Entrepreneurs, Business opportunities in India, Models for opportunity Evaluation.

Teaching-Learning Process	Chalk and talk method, Power point presentation, Field visit to understand present scenario. RBT Level:L2,L3,L4

Module-5

Business plans: Introduction, purpose of a Business plan, contents of a Business plan, presenting a Business plan, why do some Business plan fail? Procedure for setting up an Enterprise.
Institutions supporting Business opportunities: Central level institutions- National Board for micro, small & medium Enterprises(NBMSME),MSME-DO, National Small Industries Corporation. State level institutions- state Directorate Industries and commerce, District Industries Centres, state financial Corporations, State Industrial Development Corporation(SIDC),State Industrial Area Development Board (SIADB).
Other Institutions - NABARD,Technical consultancy organisation (TCO), Small Industries Development Bank of India(SIDBI), Export Promotion Councils, Non governmental Organisations.

Teaching-Learning Process	Chalk and talk method, Power point presentation, Case studies RBT Level:L2,L3,L4

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

1. Understand the fundamental concepts of Management and its functions.
2. Understand the different functions to be performed by managers/Entrepreneur.
3. Understand the social responsibilities of a Business.
4. Understand the Concepts of Entrepreneurship and to identify Business opportunities.
5. Understand the components in developing a business plan and awareness about various sources of funding and Institutions supporting Entrepreneur.

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)**

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:

Text Books:

1. Principles of Management – P.C Tripathi, P.N Reddy, McGraw Hill Education, 6th Edition, 2017. ISBN-13:978-93-5260-535-4.
2. Entrepreneurship Development Small Business Enterprises- Poornima M Charantimath,2nd Edition, Pearson Education 2018, ISBN 978-81-317-6226-4.

Reference Book:

1. Essentials of Management: An International, Innovation and Leadership perspective by Harold Koontz, Heinz Weihrich McGraw Hill Education, 10th Edition 2016. ISBN- 978-93-392-2286-4.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110107094
- https://nptel.ac.in/courses/110106141
- https://nptel.ac.in/courses/122106031

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

- Industrial visit
- Group discussion
- Role play
- Think pair share activity

PROCESS CONTROL SYSTEM			
Course Code (IPCC)	**21EI62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives: To make the students to

- Understand and remembering basics of process control and final control operation
- Understand process characteristics and controller modes
- Analyze and apply analog and digital controllers for real time applications
- Understand and remembering control loop characteristics .
- Analyze, applying and creating modelling simulation for plant automation. use of multivariable And intelligent controllers

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOT (Higher-order Thinking) questions in the class, which promotes critical thinking
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.
- Give real time Assignments..

MODULE-1

Introduction to Process Control and Final Control Operations: Introduction, Process control principles, Process control block diagram, Control system evaluation, Analog and Digital Processing, Analog data representation. **Final Control**: Introduction, Final control operation, Signal conversions, Actuators, Control elements. (Numerical problems on all topics)

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1 and L2

MODULE-2

Controller Principles: Introduction, Process characteristics, Control system parameters, Discontinuous controller modes: Two position, multiposition , floating control modes. Continuous controller modes: Proportional (P), Integral (I), Derivative (D) control modes, Composite controller modes: PI, PD, PID modes. (Problems on all types of controller modes).

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1 and L2

MODULE-3

Analog Controllers: Introduction, General features, Electronic controllers, Error detector, Single mode, Composite controller modes, Pneumatic controllers, Design considerations. (Numerical problems on all topics).
Digital Controllers: Digital electronic methods, Simple alarms, Two position control, Multivariable alarms, Data logging, Supervisory computer control (SDC) and Direct digital control. Digitized value .Sampled data systems, Input data operations. Controller Modes. Software format.

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L3 and L4

MODULE-4

Control-Loop Characteristics: Introduction, Control system configurations: single variable and cascade control, Multivariable control system. Control system quality: Definition and measure of quality. Stability: Transfer function and frequency dependence, stability criteria. Process loop tuning: Open-loop transient response method, Ziegler-Nichols method, Frequency response methods. (Numerical problems on all topics).

Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L1 and L2

MODULE 5	
Modeling and Simulation for Plant Automation: Introduction, definition of terms, Need of system modeling, Uses of system simulation, how to build the mathematical model of a plant, Model evaluation and improvement, modern tools for modeling and simulation of systems, application examples, future perspectives. **Multivariable & Intelligent Controllers**: Ratio control, Feed-forward control. Adaptive controller, Optimal control, Predictive control, Artificial intelligent based systems, Expert controller.	
Teaching-Learning Process	Chalk and talk method/power point presentation RBT levels: L3, L4 and L6

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Realize the response of first order system. plot the output response
2	Realize the response of second order system for critical damped over damped and under damped system. plot the output response.
3	Realize proportional mode control using analog controller and plot the output response.
4	Realize integral mode control using analog controller and plot the output response.
5	Realize derivative mode control using analog controller and plot the output response
6	Realize proportional-integral mode control using analog controller and plot the output response
7	Realize proportional- derivative mode control using analog controller and plot the output response
8	Realize computer control digital ALARM using Boolean logic gates
9	Study the performance of PLC CONTROLLER
10	Study the performance of FLOW CONTROLLER
11	Study the performance of LEVEL CONTROLLER
12	Study the performance of TEMPERATURE CONTROLLER

Course outcomes (Course Skill Set):

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

1. Discuss the principles of process control, evaluation, data representation and the elements of Final control operation.
2. Able to Analyze the principle and working of continuous and discontinuous controller modes.
3. Design analog controllers based op-amps and pneumatic systems.
4. Discuss the principle and working digital controllers and implementation of controller mode software, concepts and applications of modelling and simulation of process plant
5. Analyze control loop characteristics, control system quality and process loop tuning, and sketch the basic process instrumentation symbols.
6. Describe the fundamental concepts of multivariable and intelligent controllers.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). 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 scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:
Text Books

1. Process Control Instrumentation Technology by C. D. Johnson, 7th Edition, Pearson Education Private Limited, New Delhi 2002. (Modules 1, 2 3 & 4).
2. Computer Based Industrial Control by Krishna Kant, PHI, New Delhi 1997.

Reference Books:

1. Chemical Process Control – George Stephanopoulos, 4th Indian reprint, PHI Ltd., 1997.
2. Process/ Industrial Instruments and Control Handbook by D.M. Considine, 4th Edition, McGraw Hill International Edition, 1993.
3. Process dynamics and control by S.S.Bhagade and G.D.Nageshwar PHI publications New Delhi, 2011.
4. Lessons in Industrial Instrumentation by Tony R. Kuphaldt, Creative Commons Attribution License (open source textbook), Sept. 2008. (for basic instrumentation symbols, 6.5.1, 6.5.2, 6.5.3, 6.5.4, 6.5.9).
5. Instrument Engineers Handbook-Process Control Volume2 by Bela G. Liptak, Chilton Book Company/ Radnor, 3rd Edition, Pennsylyania, 1969. odule 5)

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programmes
- VTU Edu-sat programmes

- https://nptel.ac.in/courses/103105064
- https://nptel.ac.in/courses/103103037

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

- Quizzes
- Assignments
- Seminars

PLC, DCS AND SCADA IN PROCESS AUTOMATION			
Course Code (PCC)	**21EI63**	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: This course will enable the students to

- Understand basic concepts of PLC, I/O's and its Instructions set.
- Understand Programming techniques of PLC's timer/ Counter Instructions and Data handling instructions.
- Understand basic concepts of Distribution control system and its Architecture/ Applications.
- Understand concepts of Supervisory control and Data Acquisition system (SCADA) and its applications.
- Understand modelling and simulation for plant automation and usage of modern tools for plant automation.

Teaching-Learning Process (General Instructions)

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

- Always start every class hour with preamble of what was covered in previous class and what would be discussed in the present class.
- Encourage group discussions and arrange debate on certain topics.
- Try to arrange some industrial visit to understand various process automation techniques.
- Give exhaustive assignments on all topics so that students will be able to practice answering any questions in the University examinations that would come from nook and corner of the syllabus.
- Arrange seminars by the students on certain intriguing topics relevant to syllabus by the students.

Module-1

Introduction to Programmable Logic Controllers (PLC): The digital concept, Analog signals, The input status file, the output status file, input and output status file, sixteen point I/O modules, PLC addressing, PLC memory.
Input modules: Discrete input modules, Discrete AC and DC input modules
Output modules : Discrete output modules, solid-state output module switching, relay output modules

Teaching-Learning Process	Chalk and Talk Method / Power point presentation (RBT levels L1, L2 and L3)

Module-2

PLC Instructions: What is logic?, PLC programming languages, ladder programming- Conventional ladder Vs PLC ladder, the basic relay instructions: Normally open and normally closed, output and latching instructions, series and parallel function of AND, OR, NOT, XOR logic, Analysis of rung. Understanding relay instructions and the PLC input modules, interfacing start stop pushbutton and motor to PLC, developing ladder diagrams with analytical problems.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation (RBT levels L1, L2 and L3)

Module-3

Timers and Counter Instructions: Timer addressing, On delay, off delay and retentive timer instructions and associated status bits. Counter addressing, PLC counter up and down instructions and associated status bits.
Data Handling Instructions: Data handling instructions-MOVE, Masked Move, COPY. Sequencer instructions: Programming sequence output instructions, developing ladder diagram with analytical problems.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation (RBT levels L1, L2 and L3)

Module-4

Distributed Digital Control: Introduction, History, Functional requirements of Distributed Process Control System, System Architecture, Distributed Control Systems, Configuration, Some popular Distributed Control Systems, Field bus System **Text 2**: **Ch.7; 7.1 To 7.8**	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation (RBT levels L1, L2 and L3)
Module-5	
Supervisory Control and data Acquisition System: Basic Functions: Channel Scanning, conversion to Engineering units, Data Processing, Distributed SCADA System, Remote Terminal Unit, Reliable System Development Strategy. **Modeling and Simulation for Plant Automation:** Introduction, Overview of Process Models, Model Based Automatic Control, System Modeling, uses of systems simulation, How to build the mathematical model of a plant, Model evaluation & improvement, Modern tools for modeling and simulation of systems. **Text 2**: **Ch.3**; 3.6 to 3.8 and **Ch.11;** 11.1 to 11.9	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation (RBT levels L1, L2 and L3)

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

- Describe architecture, functioning and applications of PLC in automation.
- Recognize various I/O modules of PLC and apply programming concepts to interface peripherals.
- Write ladder diagram program using different PLC instruction sets
- Develop an automation system based on PLC ladder diagram program.
- Analyze the basics of distributed control system and communication protocols used in automation industries.
- Develop process automation system using SCADA and DCS.
- Develop models of process automation using modern tools.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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)**

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. Introduction to Programmable Logic Controllers, Garry Dunning, 3nd edition, Centage Learning. (Modules: 1, 2 & 3).
2. Computer based Industrial Control, Krishna Kant, 2nd edition, PHI, 2017 (Modules: 4&5)
3. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2010
4. T.A. Hughes, Programmable Controllers, Fourth edition, ISA press, 2005
5. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes

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

- Quizzes
- Assignment
- Seminars

SCIENTIFIC AND ANALYTICAL INSTRUMENTATION			
Course Code (PEC-I)	**21EI/BM641**	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 introduce the basic concept of qualitative and quantitative analysis of a given sample.
- To impart various spectroscopic techniques and its instrumentation.
- To impart the concept of separation science and its application.
- To impart methods of Industrial analyzers and its application.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes criticalthinking
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinkingskills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helpsimprove the students' understanding.

Module-1

An Introduction to Instrumental Methods: Terms associated with Chemical analysis, Classification of instrumental techniques, A review of important consideration in analytical methods, Basic functions of instrumentation, Fundamental Laws of photometry (Text book 1).

IR Spectroscopy: Basic Components of IR Spectrophotometers, monochromators- Littrow mounting, Fourier Transform IR Spectroscopy (Text book 2).

Teaching-Learning Process	Chalk and talk method, Power point presentation **RBT Level:** L1, L2

Module-2

UV and Visible Spectrometry –Instrumentation: Radiation Sources, Wavelength selection: absorption filters, interference filters, Detector, Readout modules, Instruments for absorption photometry: single beam and double beam spectrophotometer. (Text book 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation, Analytical Chemistry lab visit **RBT Level:** L1, L2, L3

Module-3

Flame Emission and Atomic Absorption Spectroscopy: Introduction, Instrumentation for flame spectrometric methods, Flame emission spectrometry, atomic absorption spectrometry, Atomic fluorescence spectrometry, Interferences associated with Flames & furnaces, applications, comparison of FES and AAS. (Text book 1).

Teaching-Learning Process	Chalk and talk method, Power point presentation, Analytical Chemistry lab visit **RBT Level:** L1, L2, L3

Module-4

Gas Chromatography: Chromatograph, Basics parts of a chromatograph: carrier gas supply, sample injection system, chromatographic columns: packed column & capillary column, Detectors: katharometer cell, differential flame ionization detector, electron capture detector.(Text book 2).

HPLC Instrumentation: Mobile –phase delivery system sample introduction, separation columns, Detectors–Ultraviolet-Visible Photometers & Spectrophotometers, electrochemical (amperometric) detector, Differential refractometer. (Text book 1).

Teaching-Learning Process	Chalk and talk method, Power point presentation, You tube videos **RBT Level:** L1, L2, L3

Module-5

Blood gas analyzer: Introduction, Blood pH measurements: electrodes for blood pH measurement, measurement of blood pCO_2, pO_2 , A Complete blood gas analyzer.

Air pollution monitoring instruments: Representation of concentration of gases, Carbon monoxide (CO) -Non-dispersive infrared analyzer, Sulphur dioxide (SO_2)-Conductivitimetry, Nitrogen oxides-Using CO laser, laser opto-acoustic spectroscopy, Hydrocarbons-Flame ionization detector, Ozone-Chemiluminescence, Automated wet chemical air analysis,

Water pollution monitoring instruments. (Text book 2)

Teaching-Learning Process	Chalk and talk method, Power point presentation, Industrial visit **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Understand the principle, construction and working of UV & IR spectroscopy.
2. Understand the principle, construction and working of Flame Emission and Atomic Absorption Spectroscopy
3. Understand the principle, construction and working of Gas & High performance Liquid Chromatograph.
4. Understand the application of analytical techniques in medicine, Industry, etc.

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 5^{th} week of the semester

2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semesterTwo

Assignments each of **10 Marks**

4. First assignment at the end of 4^{th} week of the semester
5. Second assignment at the end of 9^{th} week of the semester

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

6. At the end of the 13^{th} week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marksand 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 themethods 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 questionpapers 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 amaximum 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:

Text Books:

1. Instrumental Methods of Analysis, 7th edition. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS Publishing & Distribution.
2. Handbook of Instruments – R.S. Khandpur, Tata McGraw Hill

Reference Books:

1. Braun R.D., Introduction to Instrumental Analysis, McGraw –Hill Singapore,2006.
2. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and francis group, 2007.
3. Principles of Instrumental Analysis 5th Edition – Douglas A. Skoog, F. James Holler, Timothy A. Niemen, Thomason Brooks/ Cole

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/103108100
- https://onlinecourses.nptel.ac.in/noc20_cy18/preview
- https://freevideolectures.com/course/3029/modern-instrumental-methods-of-analysis

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

- Demonstration of analytical instruments
- Visit to chemical and food processing industries to observe the use of analytical instruments.
- Quizzes
- Assignment
- Seminars

ANALOG AND DIGITAL COMMUNICATION SYSTEMS			
Course Code (PEC-I)	**21EI/BM642**	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: this course will enable students to

- Understand and analyze concepts of analog modulation schemes such as ; Amplitude Modulation, Angle modulation, Pulse modulation.
- Understand and analyze concepts of PM and FM waves.
- Understand and analyze concepts of sampling and quantization process.
- Understand and analyze concepts of modulation techniques.
- Understand and analyze concepts of WPAN applications.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the different modulation techniques.
- Encourage group learning in the class.
- Give assignments on all topics so that the students will be able to practice any question in the University examination
- Arrange seminars by the students on certain topics relevant to syllabus.

Module-1

Introduction to analog and Digital Communication, Historical Background and Applications.
Amplitude Modulation: Amplitude Modulation, Virtues, Limitations, and Modifications of AM, DSBSC Modulation, Costas Receiver, Single Side band Modulation, Vestigial Sideband Modulation.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-2

Angle Modulation: Basic Definitions, Properties of Angle-Modulated Waves, Relationship between PM and FM Waves, NBFM, WBFM, Transmission Bandwidth of FM Waves, Generation of FM waves, Demodulation of FM Signals.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-3

Pulse Modulation: Transition from Analog to Digital Communications: Sampling Process, PAM, Completing the Transition from Analog to Digital, Quantization Process, PCM, Delta Modulation.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-4

Digital Band-Pass Modulation Techniques: Binary Amplitude Shift Keying (BASK): Generation and Detection, Binary Phase Shift-Keying (BPSK): Generation and Detection, Quadriphase Shift Keying (QPSK): Generation and Detection, Binary Frequency Shift Keying (BFSK), Minimum-Shift Keying (MSK), Differential Phase Shift Keying (DPSK): Generation and Detection.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-5

Wireless Personal Area Networks (WPAN): Network Architecture, WPAN Components, WPAN Technologies and protocols (Bluetooth &Zigbee), WPAN Applications.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

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

1. Explain the basics concepts of analog modulation techniques.
2. Discuss the basic concepts of digital modulation techniques.
3. Describe the basic concepts of digital data and pulse communication.
4. Explain and analyze different digital modulation techniques.
5. Describe different wireless area networks and their 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)**

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. Simon Haykin, John Wiley & sons, "Introduction to Analog and Digital Communications"- Second Edition, 2012, ISBN 978-81-265-3653-5.
2. Dr. SunilKumar S.Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocols", John Wiley & sons, 2014 Edition, ISBN 978-81-265-2069-5.
3. John G Proakis and Masoud Salehi, "Fundamentals of Communication Systems", 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.
4. Ian A Glover and Peter M Grant, "Digital Communications", Pearson Education, Third Edition, 2010, ISBN 978-0-273-71830-7.
5. B. P. Lathi and Zhi Ding, "Modern Digital and Analog communication Systems",
6. Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes

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

- Quizzes
- Assignment
- Seminars

VLSI DESIGN			
Course Code (PEC-I)	**21EI643**	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: This course will enable to students to;

- Impart knowledge of mass transistors theory and CMOS technology.
- Understand the basic electrical properties of mass and BICMOS circuits.
- Cultivate the concept of subsystem design and layout processes .
- Understand the concept of design process computational elements.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the functioning of various techniques.
- Encourage group learning in the class.
- Adopt problem based learning, which improves student analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Show the different ways to solve the same problem and encourage the students to come up with their creative ways to solve them.

Module-1	
Moore's law, speed power performance, nMOS fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS. **Basic Electrical Properties of MOS And BiCMOS Circuits:** Drain to source current versus voltage characteristics, threshold voltage, transconductance.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-2	
Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull down ratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter, BiCMOS inverters, latch up. **Basic Circuit Concepts:** Sheet resistance, area capacitance calculation, Delay unit, inverter delay, estimation of CMOS inverter delay, driving of large capacitance loads, super buffers, BiCMOS drivers.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-3	
MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style, design rules and layout, λ - based design. **Scaling of MOS Circuits:** scaling factors for device parameters, limitations of scaling.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-4	
Subsystem Design and Layout-1 : Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logic function block, code converter. **Subsystem Design and Layout-2 :** Clocked sequential circuits, dynamic shift registers, bus lines, subsystem design processes, General considerations, 4-bit arithmetic processes, 4-bit shifter.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

Module-5	
Design Process-Computational Elements: Regularity, design of ALU subsystem, ALU using adders, carry look ahead adders, Multipliers, serial parallel multipliers, Braun array, Bough – Wooley multiplier. **Memory, Register and Aspects of Timing:** Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flip-flop, D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimization and CAD tools for design and simulation.	
Teaching-Learning Process	Chalk and Talk Method / Power point presentation **(RBT levels L1, L2 and L3)**

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

1. Identify the CMOS layout levels, and the design layers used in the process sequence.
2. Describe the general steps required for processing of CMOS integrated circuits.
3. Design static CMOS combinational and sequential logic at the transistor level.
4. Demonstrate different logic styles such as complementary CMOS logic, pass-transistor Logic, dynamic logic, etc.
5. Interpret the need for testability and testing methods in VLSI.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

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)**

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. Basic VLSI Design -3rd Edition, Douglas A Pucknell, Kamaran Eshraghian, Prentice Hall of India publication, 2005.
2. CMOS Digital Integrated Circuits, Analysis And Design, 3rd Edition, Sung – Mo (Steve) Kang, Yusuf Leblbici, Tata McGraw Hill, 2002.
3. VLSI Technology - S.M. Sze, 2nd edition Tata McGraw Hill, 2003.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/117101058

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

- Quizzes
- Assignment
- Seminars

COMPUTER COMMUNICATION NETWORKS			
Course Code (PEC-I)	**21EI644**	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:

1. Understand the layering architecture of OSI reference model and TCP/IP protocol suite.
2. Understand the protocols associated with each layer.
3. Learn the different networking architectures and their representations.
4. Learn the functions and services associated with each layer.

Teaching-Learning Process (General Instructions)

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

- Lecture method (L): The traditional lecture method or a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various concepts in networking.
- Encourage collaborative (Group) Learning in the class.
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking .
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
- Demonstrate implementation of various protocols to help better understand the functioning of various concepts in networking.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

MODULE-1

Introduction: Uses of Computer Networks, Network Hardware, Network Software, Reference Models, Example Networks, Network Standardization

The Physical Layer: The Theoretical Basis for Data Communication, Guided Transmission Media, Wireless Transmission, Communication Satellites, The Public Switched Telephone Network,

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Animation of OSI and TCP-IP protocol suites, Self-Study: Internet standards and administration. RBT Level: L1, L2, L3

MODULE-2

The Data Link Layer: Data Link Layer Design Issues, Error Detection and Correction,
Elementary Data Link Protocols, Sliding Window Protocols, Protocol Verification, Data Link Protocols.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-3

The Medium Access Control Sub Layer: The Channel Allocation Problem,
Multiple Access Protocols, Ethernet, Wireless LANS Broadband Wireless, Bluetooth.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-4

The Network Layer: Network Layer Design Issues,
Routing Algorithms, Congestion Control Algorithms and quality of service.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE 5

The Transport Layer: The Transport Service. A Simple Transport Protocol, The Internet Transport Protocols (TCP and UDP), Performance Issues.
The Application Layer: Domain Name System (DNS), electronic mail, worldwide web.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Course Outcomes: After completion of this course the student is able to:

1. Describe the basic computer network technology.
2. Identify and analyze the different network topologies and protocols.
3. Analyze the different network devices and their functions within a network
4. Apply the knowledge in the establishing computer based networks in real world 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**)

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)**

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. Computer Networks: Andrews S. Tanenbaum, 4th Edition, Pearson Education, 2010.
2. ATM Networks concepts and Protocols – Sumit Kasera, Tata McGraw Hill 2nd edition, 2008
3. Data and computer networks- W STALLINGS 5th Edition, Prentice Hall of India 1998.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106105183.
- TCP/IP Tutorial and Technical Overview, (IBM Redbook) - Download From http://www.redbooks.ibm.com/abstracts/gg243376.html
- TCP/IP Guide, Charles M Kozierok, Available Online - http://www.tcpipguide.com/
- Request for Comments (RFC) - IETF - http://www.ietf.org/rfc.html
- https://cosmolearning.org/courses/computer-networks-524/video-lectures/
- https://www.eecis.udel.edu/~bohacek/videoLectures/ComputerNetworking/ComputerNetworking_v2.html

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

- Implementation of simple networks and various networking protocols and algorithms using simulators like NCTUns / CISCO packet tracer and measurement of various parameters using WireShark
- Implementation of simple networks and various networking protocols and algorithms in C/C++/Python

ROBOTICS AND AUTOMATION			
Course Code (PEC-I)	**21EI645**	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:

- Preparation: To prepare students with fundamental knowledge and comprehensive understanding of basic components of robot system and automation.
- Core Competence: To equip students to analyze the functions of sensors in the robot, robot kinematic and evaluate the functions of robots in different applications.
- Professionalism & Learning Environment: To inculcate an engineering student an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career.

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various learning algorithms.
- Encourage collaborative (Group) Learning in the class.
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Fundamentals of Robotics & Automation: Automation and robotics, history of robotics, robotics market and future prospects, robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot programming and work cell control, robot applications
[Textbook-1]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on history of robots. **RBT Level:** L1, L2, L3

Module-2

Robot Motion Analysis, Sensors and Control: Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, configuration of a robot controller, types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems.
Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics. [Textbook-1]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on robot motion. **RBT Level:** L1, L2, L3

Module-3

Machine Vision & Artificial Intelligence: Introduction to machine vision, sensing and digitizing function in machine vision, image processing and analysis, training the vision system, robotic applications.
Artificial Intelligence (AI): Introduction & goals of AI in research, AI techniques, LISP programming, AI & robotics, LISP in factory, robotic paradigms. [Textbook-1]

Teaching-Learning Process	.Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Module-4

Robotics in Manufacturing/Automation , Material Transfer, Machine Loading/Unloading:
Robot cell layouts, multiple robots and machine interference, considerations in work -cell design, work-cell control, interlocks, error detection and recovery, work -cell controller, robot cycle time analysis.
Material Transfer, Machine Loading/Unloading: General considerations in robot material handling, material transfer applications, machine loading and unloading.
[Textbook-1]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Module-5

Robots in Automatic Processing Operations, Assembly & Inspection: Introduction, spot welding, continuous arc welding, spray coating, other processing operations. Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote centre compliance (RCC) device, assembly system configurations, adaptable programmable assembly system, designing for robotic assembly, inspection automation. [Textbook-1]

Autonomous Mobile Robots: Introduction, Planning &Navigation: Introduction, basic control scheme for mobile robots (only basic understanding of perception, localization, path planning & motion control). [Textbook-2]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Explain the key components of robotic technologies.
2. Explain various sensors in Robots.
3. Solve problems in spatial transformation
4. Acquire knowledge in kinematic motion of Robots.
5. Formulate Motion planning techniques to navigate and perform the given task

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)**

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:

Text Books

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

Reference Books:

1. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

Web links and Video Lectures (e-Resources): • https://nptel.ac.in/courses/112105249 • https://nptel.ac.in/courses/112101098
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Programming Assignments / Mini Projects can be given to improve programming skills • Use robotic kit to develop mini robots • Visit to industries to see the working robot based automation

MEASUREMENTS, INSTRUMENTATION AND TRANSDUCERS			
Course Code (OEC-I)	**21EI651**	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 provide the fundamental knowledge of transducers, instrumentation and measurement systems.
- To understand the functional elements of instrumentation/measurement systems.
- To impart the knowledge of static and dynamic characteristics of instruments, and understand the factors in selection of instruments for measurement.
- To discuss the principle, design and working of transducers for the measurement of displacement, level, strain, force, torque, pressure, sound and speed.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Introduce the topics in a manifold representation.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Measurement, Instruments and Generalized Measurement/ Instrumentation system: Measurement, significance of measurement, Methods of Measurements, instruments and measurement systems, Mechanical, electrical and electronic instruments, Deflection & Null type instruments and their comparison, Analog and digital modes of operation, functions of instruments and measurement systems, applications of measurement systems, Elements of generalized measurement system, Input-output configuration of measuring instruments and measurement systems, methods of correction for interfering and modifying inputs.

Module-2

Characteristics of Instruments & Measurement Systems: Measurement system performance, Static calibration and error calibration curve, accuracy and precision, indications of precision, static error, relative error, static correction, scale range and scale span, reproducibility and drift, repeatability, signal to noise ratio, static sensitivity, linearity, hysteresis, threshold, dead time and dead zone, resolution.

Transducers: Definition of Transducers, Classifications of transducers-based on principle, primary & secondary transducers, active & passive transducers, analog and digital transducers, transducers & inverse transducers, summary of factors influencing the choice of transducers/instruments.

Module-3

Transducers/Instruments for Measurement of Displacement: Introduction, Principles of Transduction, Variable resistance devices, Variable Inductance Transducer-LVDT, variable reluctance, Synchros and Resolvers, Variable Capacitance Transducer, Hall Effect Devices, Digital Transducer.

Transducers/Instruments for Measurement of Level: Capacitance probes – bare and coated capacitance probes, Conductivity probes, Float level devices – atmospheric tanks, mercury float switch, pneumatic float switch, Optical level switches-Noncontact level sensor, contacting level sensor, laser based level detector, Ultrasonic level detector-On-ff and continuous, Thermal level sensors

Module-4

Transducers/Instruments for Measurement of Strain: Introduction, Types of Strain Gauges, Theory of operation of resistance strain gauges, Types of Electrical Strain Gauges – Wire gauges, unbounded strain gauges, foil gauges, Semiconductor strain gauges (principle, types & list of main characteristics only), Strain gauge Circuits – Wheatstone bride circuit (quarter bridge, half bridge and full bridge), Applications.

Transducers/Instruments for Measurement of Force & Torque: Introduction, Force measuring sensor – Load

cells – column types devices, proving rings, cantilever beam, pressductor. Hydraulic load cell, Electronic weighing system. Torque measurement: Absorption type, transmission type, stress type & deflection type.

Module-5

Transducers/Instruments for Measurement of Pressure: Introduction, Diaphragms, Other elastic elements, Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device (principle & working, no derivation), force balance transducer with analysis, Thin film pressure transducers, Digital pressure transducer, Piezoelectric pressure transducer, Pressure multiplexer, Pressure calibration.

Course Outcomes: After studying this course, students will able to:

- Define the transducer, instrument, measurement and classify different types of transducers
- Explain the functional elements of instrumentation / measurement systems
- Discuss the input-output configuration of measurement systems
- Define, interpret and analyze the static and dynamic characteristics of instruments
- Explain the principle, design and analyze the transducers for the measurement of displacement, level, strain, force, torque, and pressure.

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)**

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:

Text Books:

1. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai& Co. Pvt. Ltd., 2004. (Module 1 & 2)
2. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 3-Displacement measurement, Module 4, and Module 5)
3. Process Measurement Instrument Engineers Handbook- Bela G. Liptak, Revised Edition, Chilton Book Company, 1982. (Module 3 – Level measurement**)**

Reference Books:

1. Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009.
2. Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007.
3. Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009.
4. Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105153
- https://nptel.ac.in/courses/108105064
- https://www.youtube.com/watch?v=hxfOdn8Bjh8
- https://www.youtube.com/watch?v=As5kzxkyT24

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

- Explore the use of different type of instruments and transducers being used in the real world situation.
- Demonstration of instruments and transducers in the laboratory.
- Develop mini projects using instruments and transducers.

ANALYTICAL INSTRUMENTATION			
Course Code (OEC-I)	**21EI652**	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 introduce the basic concept of qualitative and quantitative analysis of a given sample.
- To impart various spectroscopic techniques and its instrumentation.
- To impart the concept of separation science and its application.
- To impart methods of Industrial analyzers and its application.

Teaching-Learning Process (General Instructions)

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

- Show Video/animation films to explain the functioning of various image processing concepts.
- Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
- Encourage students to ask questions and investigate their own ideas helps improve theirproblem-solving skills as well as gain a deeper understanding of academic concepts.
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes criticalthinking.
- 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.
- Topics will be introduced in multiple representations.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Arrange visits to nearby PSUs such as CAIR(DRDO), NAL, BEL, ISRO, etc., and small-scale software industries to give industry exposure.

Module-1

An Introduction to Instrumental Methods: Terms associated with Chemical analysis, Classification of instrumental techniques, A review of important consideration in analytical methods, Basic functions of instrumentation (Text book 1).

IR Spectroscopy: Basic Components of IR Spectrophotometers, monochromators- Littrow mounting, Fourier Transform IR Spectroscopy (Text book 2).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3

Module-2

Colorimeters and Spectrophotometers(Visible - Ultraviolet): Electromagnetic radiation, The Beer Lambert Law, Absorption instruments ,Colorimeters, Spectrophotometers-Single beam Null Type Spectrophotometer , Microprocessor based Spectrophotometer, Sources of error in Spectro photometric measurements.(Text book 2)

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3

Module-3

Flame Photometers: Principle of Flame Photometry, Constructional details of Flame photometers, clinical flame photometers, Interferences in flame photometry, procedure for determinations.

Thermo-Analytical Methods: Thermogravimetric analysis(TGA), Differential thermal analysis(DTA) (Text book 2).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos. **RBT Level:** L1, L2, L3

Module-4

Gas Chromatography: Chromatograph, Basics parts of a chromatograph: carrier gas supply, sample injection system, chromatographic columns: packed column & capillary column, Detectors: katharometer cell, differential

flame ionization detector, electron capture detector.(Text book 2).

HPLC Instrumentation: Mobile –phase delivery system sample introduction, separation of columns, Detectors– Ultraviolet Photometers & Spectrophotometers, electrochemical detector (amperometric detector), Differential refractometer. (Text book 1).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3

Module-5

Industrial gas analyzers : Types of gas analyzers, Magnetic wind instruments. Infrared gas analyzer, Thermal conductivity analyzers, analyzers based on gas density, method based on Ionization of gases

Air pollution monitoring instruments: Carbon monoxide (CO) -Non-dispersive infrared analyzer, Sulphur dioxide (SO_2)-Conductivitimetry, UV fluorescence method, Nitrogen oxides-Using CO laser, laser opto-acoustic spectroscopy, Hydrocarbons-Flame ionization detector, Ozone-Chemiluminescence, Automated wet chemical air analysis,

Water pollution monitoring instruments. (Text book 2)

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Understand the principle, construction and working of UV & IR spectroscopy.
2. Understand the principle, construction and working of Flame Emission and Atomic Absorption Spectroscopy
3. Understand the principle, construction and working of Gas & High performance Liquid Chromatograph.
4. Understand the application of analytical techniques in pollution monitoring, Industry, etc.

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)**

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:

Text Books:

1. Instrumental Methods of Analysis, 7th edition. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS Publishing & Distribution (Module 1 and Module 4-HPLC).
2. Handbook of Analytical Instruments – R.S. Khandpur, Tata McGraw Hill (Module 1-IR Spectroscopy, Module2,Module 3, Module 4-GasChromatography, Module 5)

Reference Books:

1. Braun R.D., Introduction to Instrumental Analysis, McGraw –Hill Singapore,2006.
2. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and Francis group, 2007.
3. Principles of Instrumental Analysis 5th Edition – Douglas A. Skoog, F. James Holler, Timothy A. Niemen, Thomason Brooks/ Cole

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/103108100
- https://onlinecourses.nptel.ac.in/noc20_cy18/preview
- https://freevideolectures.com/course/3029/modern-instrumental-methods-of-analysis

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

1. Visit to Analytical chemistry lab
2. Quizzes

OPTICAL INSTRUMENTATION			
Course Code (OEC-I)	**21EI653**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives: this course will enable the students to:

- Understand the basic concepts of Lasers.
- Understand and analyze the classification of Lasers and their energy level diagram.
- Understand and analyze the key elements of Optical Fibre systems.
- Understand the Optical amplifiers and its applications.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the functioning of various techniques.
- Encourage group learning in the class.
- Try to arrange some industrial visit to understand various Lasers.
- Give assignments on all topics so that the students will be able to practice any question in the University examination.
- Arrange seminars by the students on certain topics relevant to syllabus.

Module -1	
Introduction to Laser (Lasers -I): Introduction, Emission and absorption of radiation, Einstein relation, population inversion, optical feedback, threshold conditions, Line shape function, population inversion and pumping threshold conditions**.** **Classes of Laser:** Doped insulator Lasers, semiconductor Lasers, Gas Lasers, Liquid dye Lasers. (Textbook-1)	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos **RBT Level:** L1, L2, L3
Module -2	
Lasers-II: Single mode operation, frequency stabilization, Mode locking and Q-switching. **Applications of Laser:** Measurement of distance: Interferometric methods, Beam modulation telemetry; Holography & Holography interferometry. (Textbook-1)	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3
Module -3	
Optical Fiber Communications: Motivations for light wave communications, optical spectral bands, Network information rates, WDM concepts, Key elements of optical fiber systems, standards for optical fiber communications, Modeling and simulation tools. **Optical Fibers: Structures, Wave guiding, and Fabrication:** The nature of light, basic optical laws and definitions, optical fiber modes and configurations. (Textbook-2)	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3
Module -4	
Types of Fibers, Material and Fabrication: Single mode fibers, Graded index fiber structure, Fiber materials, Photonic crystal fibers, Fiber fabrication, Fiber optic cables. **Optical Amplifiers:** Types of optical amplifiers and its applications, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers, Amplifier noise, Optical SNR, System, Raman amplifiers. (Textbook-2)	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3
Module -5	
Applications of Lasers in Medicine: Fiberoptic laser systems in cardiovascular disease-Endoscopic laser systems in cardiology, Fiber-optic laser therapy-angioplasty, Endoscopic Nd:YAG Laser therapy in gastroenterology, Laproscopic laser surgery, ophthalmological applications of laser-fiber systems, arthroscopic surgery in orthopaedics, laser lithotripsy. (Textbook-3)	
Teaching-Learning	Chalk and talk method, PowerPoint Presentation, YouTube videos

Process	RBT Level: L1, L2, L3

Course Outcomes: After studying this course, students will be able to:

1. Explain the principle and working of Laser system.
2. Discuss the engineering applications of laser systems.
3. Discuss the fundamentals of optical fiber communications.
4. Evaluate the design of optical fibers.
5. Apply fiber optic laser systems in medical field.

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)**

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:

Text Books:

1. Optoelectronics- An Introduction-Wilson & Hawkes, Prentice Hall of India.
2. Optical fiber communications-Geird Keser, McGraw Hill education (India) private limited, Fifth edition.
3. Lasers and Optical Fibers in Medicine - by Abraham Katzir, Academic Press, 1998.

Reference Books:

1. LASER Fundamentals- William T. Silfvast, Cambridge University Press.
2. Essentials of Opto Electronics with Applications - A.J. Rogers, CRC press 1997.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/102/108/102108082/
- https://nptel.ac.in/courses/102108082
- https://onlinecourses.nptel.ac.in/noc22_ee67/preview

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

- Demonstration of optical sensors and instruments.
- Mini projects using optical sensors and optical instruments.
- Quizzes, Assignments and Seminars

AVIONICS AND AIRCRAFT INSTRUMENTATION			
Course Code (OEC-I)	**21EI654**	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: This course will enable to students to;

- Understand and analyze the basic concept of Aircraft Instruments.
- Understand and analyze the Air data Instruments.
- Understand and analyze the concept of Altimeters and gyroscopic flight instruments.
- Understand and analyze the concept of Aircraft engine Instruments.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the functioning of various techniques.
- Encourage group learning in the class.
- Try to arrange some industrial visit to understand various Aircraft Instruments.
- Give assignments on all topics so that the students will be able to practice any question in the University examination
- Arrange seminars by the students on certain topics relevant to syllabus.

Module-1

Aircraft Instruments: Introduction-Qualitative and quantitative displays, basic T grouping of instruments, basics of Altitude Director Indicator (ADI) &Horizontal Situation Indicator.

Air Data Instruments: Pneumatic type and air data computers, International Standard Atmosphere (ISA), combined pitot-static probe, separate static probe, air speed indicator, instantaneous vertical speed indicator.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation **RBT levels L1, L2 and L3**

Module-2

Altimeters, **Air Data Warning System:** Mach warning system, altitude alerts system, airspeed warning system.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-3

Directional Systems: Earth's total magnetic field, horizontal and vertical components of total field direct reading compass and its limitations, fluxgate detector units. gyro stabilized direction indicating systems.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-4

Gyroscopic Flight Instruments: types of gyros-mechanical, ring laser gyros, fiber optic gyros and their limitations, basic mechanical gyro and its properties namely rigidity and precision, gyro horizon, direction indicator, turn and bank indicator.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-5

Engine Instruments: pressure measurement (EPR), Temperature measurement (EGT), capacitance type volumetric fuel quantity indicator, densitometer, fuel quantity indicator by weight. Engine speed measurement, torque measurement, integrated impellor type flow meter.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

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

1. Outline the scope and extent of avionics and identify the types of flight instruments and display panels.
2. Describe the fundaments of flight, basics of aircraft structures, propulsion and materials used in the development of an aircraft.
3. Comprehend the complexities involved during development of flight vehicles.
4. Recognize the fundamental applications of gyroscopic flight instruments in aircraft and analyses the

performance of aircraft control system and interpret the results.

5. Evaluate the performance characteristics of engine instruments of aircraft and give better view and ways to improve efficiency.

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)**

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. Aircraft Instruments and Integrated Systems- EHJ Pallet, Longman Scientific & Technical, 1992.
2. Aircraft Instrumentation and Systems -S. Nagabhushana & L.K. Sudha, IK International
3. Aircraft Systems: Mechanical, electrical, and avionics subsystems integration - Ian Moir and Allan Seabridge, Third Edition, John Wiley & Sons, Ltd., 2008.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/101104071
- https://nptel.ac.in/courses/101101079

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

- Quizzes
- Assignment
- Seminars

PROCESS CONTROL AND VIRTUAL INSTRUMENTATION LAB			
Course Code (PCC Lab)	**21EIL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0 : 0 : 2 : 0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

- Understand the design concepts of measurement and signal conditioning of various physical variable such as temperature and strain using various sensors.
- Understand design concepts of OPAMP based P, I, and D as well as PI & PD modes of controller and its implementation
- Understand the programming techniques of virtual instrumentation using lab view.
- Understand programming of PLCs on certain applications in demonstration experiments.

Sl.NO	Experiments
1	Rig up and test the circuit to display the temperature using RTD/Thermistor with suitable signal conditioning circuit.
2	Rig up and test the circuit to display the temperature using IC AD590 / LM35 with suitable signal conditioning circuit.
3	Rig up and test the circuit to display the load/ strain using load cell/ strain gauge with suitable signal conditioning circuits.
4	Realize Op-amp based Proportional (P), Derivative (D) and Integral (I) analog controller modes.
5	Realize Op-amp based PI and PD composite analog controller modes.
6	Conduct an experiment to perform and analyze PC based temperature/pressure controller. Plot the optimum response of different controller modes for different set-points.
7	Conduct an experiment to perform and analyze PC based level/flow controller. Plot the optimum response of different controller modes for different set-points.
8	Basic operations, simple programming structure using LabVIEW. (i) Basic arithmetic operations (ii) Boolean operations (iii) Sum of 'n' numbers using 'for' loop (iv) Sorting even numbers using 'while' loop in an array
9	Creation of a CRO using LabVIEW and measurement of frequency and amplitude.
10	Data acquisition using LabVIEW for temperature measurement with thermocouple and AD590
	Demonstration Experiments (For CIE)
11	Realization of basic gate functions using PLC. The logic should be solved using ladder diagram. (i) AND (ii)OR (iii)NAND(iv) XOR(v)NOR (vi)Latch and Unlatch of output
12	Study and demonstration of working of different types of Timers and Counters of PLC. The logic should be solved using ladder diagram.
13	Study and demonstration of Bottle Filling Process using PLC. The logic should be solved using ladder diagram.

Course outcomes (Course Skill Set):

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

- Demonstrate the skill set in designing the signal conditioning circuits for various physical variables using different types of sensors.
- Demonstrate the skill set of programming computer based PID controllers.
- Acquire required skill set for virtual instrumentation using lab view programming techniques.
- Demonstrate the skill set of programming PLCs in demonstration experiments enlisted in the syllabus.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources: Books

- Introduction to Programmable Logic Controllers, Garry Dunning, 3nd edition, Centage Learning.
- Computer based Industrial Control, Krishna Kant, 2nd edition, PHI, 2017.
- F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2010
- T.A. Hughes, Programmable Controllers, Fourth edition, ISA press, 2005
- Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004
- www.udemi.com
- https://learn.ni.com
- https://m.youtube.com

MINI PROJECT			
Course Code (MP)	**21EIMP67**	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	02	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	02	Exam Hours	

INNOVATION/ENTREPRENEURSHIP /SOCIETAL INTERNSHIP			
Course Code (INT)	**21INT68**	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	--	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2021 - 22)

VII Semester

BIOMEDICAL INSTRUMENTATION			
Course Code (PCC)	**21EI71**	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:

This course will enable the students

To provide the fundamental knowledge of Bio-medical Instrumentation, the science associated with the measurement of biological variables such as pressure, temperature etc related to human body, the complexities associated with the measurement of the biological parameters and the care that are to be taken for the measurement since it is concerned with human life.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- 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.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Fundamentals of Biomedical Instrumentation: Sources of biomedical signals, Basic Medical Instrumentation system, Performance requirements of medical instrumentation systems. PC based medical instruments, General constraints in design of biomedical instrumentation systems.

Bioelectric Signals and Electrodes : Origin of Bioelectric signals, Types of bioelectric signals-ECG, EEG, EMG, Recording electrodes: Electrode – Tissue interface, polarization, skin contact- impedance, Silver-silver chloride electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes.(Text book 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation RBT Level: L1, L2, L3

Module-2

Electrocardiograph: Physiology of the heart, Electrical activity of the heart and Electrocardiogram (ECG), Normal & Abnormal cardiac Rhythms, Block diagram-description of an Electrocardiograph, ECG leads, Effects of artifacts on ECG Recordings, Multi- channel ECG machine.(Text book 1)

Electroencephalograph: Block diagram description of an Electroencephalograph, 10-20 electrode systems, computerized analysis of EEG. Electromyography, Biofeedback instrumentation.(Textbook 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit RBT Level: L1, L2, L3

Module-3

Patient Monitoring System: Bedside patient monitoring systems, Central monitors, Measurement of heart rate Average heart rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Definition of oximeter & Pulse oximeter.
Blood Pressure Measurement: Introduction, Indirect methods of blood pressure measurement: Korotkoff's method, Rheographic method, differential auscultatory technique, Oscillometric technique.
Measurement of Respiration Rate: Impedance pneumography, CO_2 method of respiration rate measurement, Apnoea detectors.(Text book 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation RBT Level: L1, L2, L3

Module-4

Blood Flow Measurement: Electromagnetic blood flow meter- Principle and Square wave electromagnetic flowmeter. Doppler shift blood flow velocity meter, Blood flow measurement by Doppler imaging.
Cardiac Output Measurement: Measurement of continuous cardiac output derived from the aortic pressure waveform, ultrasound method.
Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable pacemakers, Programmable pacemakers, Power sources for Implantable pacemaker.
Cardiac Defibrillator: Need for a Defibrillator, DC defibrillator, Pacer-Cardioverter-Defibrillator(Textbook 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit RBT Level: L1, L2, L3

Module-5

Therapeutic Instruments:
Cardiac-assist devices, Pump oxygenators, Total artificial heart, Hemodialysis, Lithotripsy, Ventilators, Infant incubators, Drug infusion pumps, Ambulatory and Implantable Infusion systems, Anesthesia Machines, Electrosurgical unit.(Textbook 2)
Patient Safety: Electric shock hazards, Leakage currents, Electrical safety analyzer, Testing of Biomedical equipment.(Textbook 1)

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit RBT Level: L1, L2, L3

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

1. Acquire knowledge about origin of bio-potential, bio-signals and their measurement
2. Describe the problem, identify and formulate solution in the field of Bio-Medical Engineering for current and future issues
3. Describe the cardiac, brain and muscular physiological systems with the related diagnostic measurement methods.
4. Recognize the therapeutic methods of treatment and the associated instrumentation.
5. Identify and judge patient safety issues related to biomedical instrumentation.
6. Describe the principle and working of cardiac pacemakers, defibrillators, BP measurement, blood flow meters, CO measurement, respiration measurements and their implementation

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 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semesterTwo

Assignments each of **10 Marks**

4. First assignment at the end of 4^{th} 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 **20Marks** (**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 marksand 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 themethods 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 questionpapers 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.
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:

Text Books:

1. Handbook of Biomedical Instrumentation - R.S.Khandpur, 2nd Edition, Tata McGraw- Hill, 2003
2. Medical Instrumentation: Application and Design – John G Webster, 3rd Edition, John Wiley & Sons, 2006.

Reference Book:

1. Biomedical Instrumentation & Measurement - Leslie Cromwell, Fred J Weibell& Erich A Pfeiffer, 2nd Edition, Prentice Hall of India, 2001.

Web links and Video Lectures (e-Resources):

- https://lecturenotes.in/subject/27/biomedical-instrumentation-bi/video
- https://www.electrical4u.com/introduction-to-biomedical-instrumentation/

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

- Visit to hospitals, clinics and diagnostic centres.
- Quizzes
- Assignment
- Seminars

LASERS AND OPTICAL INSTRUMENTATION			
Course Code (PCC)	**21EI72**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	02	Exam Hours	03

Course objectives: this course will enable the students to:

- Understand the basic concepts of Lasers.
- Understand and analyze the classification of Lasers and their energy level diagram.
- Understand and analyze the key elements of Optical Fibre systems.
- Understand the Optical amplifiers and its applications.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the functioning of various techniques.
- Encourage group learning in the class.
- Try to arrange some industrial visit to understand various Lasers.
- Give assignments on all topics so that the students will be able to practice any question in the University examination
- Arrange seminars by the students on certain topics relevant to syllabus.

Module-1

Lasers -I: Introduction, Emission and absorption of radiation, Einstein relation, population inversion, threshold conditions, Line shape function, population inversion and pumping threshold conditions**.**
Lasers -II: Classes of LASER: Doped insulator LASERs, semiconductor LASERs, Gas LASERs, Liquid dye LASERs.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-2

Generation of Lasers: Single mode operation, frequency stabilization. Q-switching, mode locking, lasing threshold.
Applications of Laser: Measurement of distance: Interferometric methods, Beam modulation telemetry, Pulse echo techniques; Holography & its Applications.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-3

Overview of Optical Fiber Communications: Motivations for light wave communications, optical spectral bands, Decibel units, Network information rates, WDM concepts, Key elements of optical fiber systems, standards for optical fiber communications.
Structures, Wave guiding, and Fabrication I: The nature of light, basic optical laws and definitions, optical fiber modes and configurations, Mode theory for circular waveguides, Single mode fibers.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-4

Structures, Wave guiding, and Fabrication II: Graded index fiber structure, Fiber materials, Photonic crystal fibers, Fiber fabrication, Mechanical properties of fibers, Fiber optic cables.
Optical Amplifiers: Types of optical amplifiers and its applications, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers, Amplifier noise, Optical SNR, System Applications, Raman amplifiers, wideband optical amplifiers.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-5

Applications of Fiber Optic Laser Systems in Medicine: Introduction, Fiberoptic laser systems in cardiovascular disease-Endoscopic laser systems in cardiology, Fiber-optic laser therapy-angioplasty, Endoscopic Nd:YAG Laser therapy in gastroenterology, Laproscopic laser surgery, photodynamic therapy inoncology,

ophthalmological applications of laser-fiber systems, arthroscopic surgery in orthopedics, laser lithotripsy, flowchart diagrams for clinical applications of laser-fibersystems-advances.
Textbook 3: Unit 9.1, 9.2, 9.2.1, 9.2.2, 9.2.5, 9.3.4, 9.5.2.3, 9.7.3, 9.8.2, 9.9.2, 9.11.4.3

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

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

1. Explain the principle and working of Laser system.
2. Discuss the engineering applications of laser systems.
3. Discuss the fundamentals of optical fiber communications.
4. Evaluate the design of optical fibers.

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

Suggested Learning Resources: Books

1. Optoelectronics- An Introduction-Wilson & Hawkes, Prentice Hall of India.
2. Optical fiber communications-GeirdKeser, McGraw Hill education (India) private limited, Fifth edition.
3. Lasers and Optical Fibers in Medicine - by Abraham Katzir, Academic Press, 1998.
4. LASER Fundamentals- William T. Silfvast, Cambridge University Press.
5. Essentials of Opto Electronics with Applications - A.J. Rogers, CRC press 1997.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/102/108/102108082/
- https://nptel.ac.in/courses/102108082
- https://onlinecourses.nptel.ac.in/noc22_ee67/preview

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

- Demonstration of optical sensors and instruments.
- Quizzes, Assignments & Seminars

AERONAUTICAL INSTRUMENTATION			
Course Code (PEC)	**21EI731**	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: This course will enable to students to;

- Understand and analyze the basic concept of Aircraft Instruments.
- Understand and analyze the Air data Instruments.
- Understand and analyze the concept of Altimeters and gyroscopic flight instruments.
- Understand and analyze the concept of Aircraft engine Instruments.

Teaching-Learning Process (General Instructions)

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

- Lecturer method (L) does not mean only the traditional lecturer method, but a different type of teaching method may be adopted to develop the outcomes.
- Show video/ animation films to explain the functioning of various techniques.
- Encourage group learning in the class.
- Try to arrange some industrial visit to understand various Aircraft Instruments.
- Give assignments on all topics so that the students will be able to practice any question in the University examination
- Arrange seminars by the students on certain topics relevant to syllabus.

Module-1

Aircraft Instruments: Introduction-Qualitative and quantitative displays, basic T grouping of instruments, basics of Altitude Director Indicator (ADI) &Horizontal Situation Indicator.

Air Data Instruments: Pneumatic type and air data computers, International Standard Atmosphere (ISA), combined pitot-static probe, separate static probe, air speed indicator, instantaneous vertical speed indicator.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-2

Altimeters, **Air Data Warning System:** Mach warning system, altitude alerts system, airspeed warning system.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-3

Directional Systems: Earth's total magnetic field, horizontal and vertical components of total field direct reading compass and its limitations, fluxgate detector units. gyro stabilized direction indicating systems.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-4

Gyroscopic Flight Instruments: types of gyros-mechanical, ring laser gyros, fiber optic gyros and their limitations, basic mechanical gyro and its properties namely rigidity and precision, gyro horizon, direction indicator, turn and bank indicator.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-5

Engine Instruments: pressure measurement (EPR), Temperature measurement (EGT), capacitance type volumetric fuel quantity indicator, densitometer, fuel quantity indicator by weight. Engine speed measurement, torque measurement, integrated impellor type flow meter.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

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

1. Outline the scope and extent of avionics and identify the types of flight instruments and display panels.
2. Describe the fundaments of flight, basics of aircraft structures, propulsion and materials used in the development of an aircraft.
3. Comprehend the complexities involved during development of flight vehicles.
4. Recognize the fundamental applications of gyroscopic flight instruments in aircraft and analyses the performance of aircraft control system and interpret the results.
5. Evaluate the performance characteristics of engine instruments of aircraft and give better view and ways to improve efficiency.

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)**

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. Aircraft Instruments and Integrated Systems- EHJ Pallet, Longman Scientific & Technical, 1992.
2. Aircraft Instrumentation and Systems -S. Nagabhushana & L.K. Sudha, IK International
3. Aircraft Systems: Mechanical, electrical, and avionics subsystems integration - Ian Moir and Allan Seabridge, Third Edition, John Wiley & Sons, Ltd., 2008.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/101104071
- https://nptel.ac.in/courses/101101079

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

- Quizzes
- Assignment
- Seminars

BIOMEDICAL SIGNAL PROCESSING			
Course Code (PEC)	**21EI732**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

This course will enable students to:

- Explain the origin of biomedical signals, their characteristics.
- Detect events and patterns in biomedical signals.
- Apply classical spectral analysis techniques to evaluate/estimate biomedical signals.
- Develop algorithms for noise and artifact removal in biomedical signals.
- Apply data reduction techniques on ECG signal. Possess the basic mathematical, scientific and computational skills necessary to analyse ECG and EEG signals..

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives of Biomedical Signal analysis, Difficulties in Biomedical Signal analysis.
(Text-1: 1.1, 1.2, 1.3, 1.4)

Electrocardiography: Techniques used in electrocardiography, ECG Electrodes, the cardiac equivalent generator, genesis of the ECG, the standard and augmented limb leads, 12 lead ECG, the vectorcardiogram, ECG signal characteristics.
(Text-2: 2.1, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.1, 2.2.2, 2.3)

Signal Conversion: Simple signal conversion systems, Conversion requirements for biomedical signals (Text-2).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3

Module-2

Signal Averaging: Basics of signal averaging, Signal averaging as a digital filter, a typical averager, Software for signal averaging, Limitations of signal averaging.
(Text-2: 9.1, 9.2, 9.3, 9.4, 9.5).

Adaptive Filters: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, Applications: Maternal ECG in fetal ECG, Cardiogenic artifact, detection of ventricular fibrillation and tachycardia. (Text-2: 8.1, 8.2, 8.3.1, 8.3.2, 8.3.3).

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3

Module-3

Data Reduction Techniques: Introduction, Turning point algorithm, AZTEC algorithm, Fano algorithm, Huffman coding: Static coding, Modified coding, Adaptive coding, Residual differencing, Runlength coding.
(Text-2: 10.1, 10.2, 10.3, 10.4.1, 10.4.2, 10.4.3, 10.4.4, 10.4.5).

Time and Frequency domain techniques: The Fourier transform for a discrete nonperiodic and periodic signals, the Fast Fourier transform, Correlation in time domain and in frequency domain, Convolution in time domain and in frequency domain, Power spectrum estimation: Parseval's theorem
(Text-2: 11.1.1, 11.1.2, 11.1.3, 11.2.1, 11.2.2, 11.2.3, 11.3.1, 11.3.2, 11.3.3, 11.4.1)

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3

Module-4

ECG QRS detection: Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques: Template cross correlation, template subtraction, automata based template matching, a QRS detection algorithm.
ECG Analysis Systems: Interpretation of the 12 lead ECG, ST segment analyzer, Portable arrhythmia monitor: Holter recording, software and hardware design, arrhythmia analysis (Text -2)

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3

Module-5

Neurological signal processing: The brain and its potentials, origin of brain waves, the EEG signal and its characteristics, EEG analysis, Linear prediction theory, The Autoregressive method, Recursive estimation of AR parameters, Spectral error measure.
(Text-3: 4.1, 4.2, 4.3 4.4, 4.5, 4.6, 4.7, 4.8)
Event detection and waveform analysis: EEG rhythms, waves and transients, Detection of EEG rhythms, Template matching for EEG spike and wave detection, the matched filter.
(Text-1: 4.2.4, 4.4.1, 4.4.2, 4.6)

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos RBT Level: L1, L2, L3

Course outcome (Course Skill Set)

1. At the end of the course the student will be able to :
2. Describe the origin, properties and suitable models of important biological signals such as ECG and EEG.
3. Know the basic signal processing techniques in analysing biological signals.
4. Acquire mathematical and computational skills relevant to the field of biomedical signal processing.
5. Describe the basics of ECG signal compression algorithms.
6. Know the complexity of various biological phenomena.

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)**

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. Biomedical Signal Analysis-Rangaraj M Rangayyan, John Wiley & Sons 2002
2. Biomedical Digital Signal Processing- Willis J Tompkins, PHI2001.
3. Biomedical Signal Processing Principles and Techniques-D C Reddy, McGraw-Hill publications, 2005

Web links and Video Lectures (e-Resources):

- http://nptel.ac.in/courses/108105101/7
- https://swayam.gov.in/course/4443-biomedical-signal-processing
- https://ocw.mit.edu/terms.

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

- Programming Assignments / Mini Projects can be given to improve programming skills
- Implementation of algorithms using Matlab / Scilab

MECHATRONICS			
Course Code (PEC)	**21EI733**	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 provide the basic concepts and building blocks of mechatronic system.
- To understand the special types of sensors and transducers used in mechatronic systems.
- To impart the fundamental knowledge of various types of actuators.
- To understand the basic concepts of fault finding, reliability and integration of systems.
- To impart the knowledge of microcontroller interfacing and development of modular systems.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts and working of sensors/ transducers, actuators and mechatronic systems.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Introduction: Introduction to Mechatronics, Design process, Systems, Measurement systems, Control systems, Examples of mechatronic systems: Digital camera with autofocus, Engine management system.

Sensors and Transducers (only selected topics): Smart sensors, Pneumatic sensors, Proximity switches, Pyroelectric sensors, Piezoelectric sensors, Tactile sensor. [Textbook-1]

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1, L2 and L3

Module-2

Pneumatic And Hydraulic Actuation Systems: Actuation systems, Pneumatic and hydraulic systems, Directional control valves, Pressure control valves, Servo and proportional control valves, Process control valves, Rotary actuators.

Mechanical Actuation Systems: Mechanical systems, Types of motion, Kinematic chains, Cams, Gears, Belt and chain drives, Bearings.[Textbook-1]

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1, L2 and L3

Module-3

Electrical Actuation Systems: Electrical systems, Mechanical switches, Solenoids, D.C. motors, A.C. motors, Stepper motors.

Fault Finding: Fault-detection techniques, Watchdog timer, Parity and error coding checks, Common hardware faults, Microprocessor systems, Emulation and simulation. [Textbook-1]

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1, L2 and L3

Module-4

Interfacing Microcontrollers with Actuators: Introduction, Interfacing with general purpose three state transistors, Interfacing relays, Interfacing solenoids, Interfacing stepper motors, interfacing permanent magnet motors, Interfacing sensors, Interfacing with DAC, interfacing power supplies, Compatibility at an interface.

Reliability: Meaning of reliability**,** The life curve, Repairable and non-repairable systems, Failure or hazard rate models, Reliability systems, Response surface modeling. [Textbook-2]

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1, L2, L3 and L4

Module-5

Components Based Modular Design and System Validation: Introduction, Components based modular design view, System validation, Validation methodology, Validation scheme, Fusion technique-An example with vision system.

Integration: Introduction, Background, Advanced actuators, Industrial robot, Autonomous guided vehicle (AGV), Drilling machine for PCB board. [Textbook-3]

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1, L2 and L3

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

1. Describe and analyze the mechatronic systems and their associated systems.
2. Discuss and illustrate different types of actuation systems that can be employed in a mechatronic system.
3. Demonstrate the integration of mechatronic systems.
4. Identify and solve the faults in mechatronic systems and assess the reliability.
5. Design and develop microcontroller and actuator based mechatronic system.
6. Design modular system and perform validation.

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)**

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:

Text Books:

1. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering– W. Bolton, Pearson Education Asia, 4th Edition, 2013. (Chapter 1, 2, 7, 8, 9 & 16)
2. Mechatronics: Principles and Applications – Godfrey C. Onwubolu, Elsevier (BH) Publications, India Reprint 2013. (Chapter 11 & 17).
3. Mechatronics: Principles, Concepts and applications – Nitaigour Premchand Mahailik, TMH, 2003.

Reference Books:

1. Introduction to mechatronics and measurement systems –David G. Alciatore & Michel BiHistand, Tata McGraw Hill –2000.
2. Mechatronics H.D. Ramachandra, Sudha Publication 2003 Mechatronics by HMT Ltd. Tata McGraw-Hill, 2000.
3. Mechatronics System design by Devadas Shetty and Richard A. Kark, Thomas Learning, 1997.
4. Mechatronics an Introduction by Robert H Bishop, CR, 2005.
5. Mechatronics Systems Fundamentals by Rolf Isermann, Springer, 2005

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112107298
- https://www.cet.edu.in/noticefiles/259_Lecturer%20Note%20on%20Mechatronics-ilovepdf-compressed.pdf
- https://nptel.ac.in/courses/112103174

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

- Explore the use of different type of sensors /transducers and actuators being used in the mechatronic systems.
- Demonstration of sensors/transducers and actuators in the laboratory.
- Develop mini projects using sensors /transducers, actuators and microcontrollers.
- Observe the working of household / consumer based mechatronics and write a report.

MEDICAL IMAGING TECHNIQUES			
Course Code (PEC)	**21EI734**	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:

This course will enable the students to:

1. Understand the origin of Electromagnetic radiation.
2. Identify the different modalities X-ray, Ultrasound, CT, MRI, Nuclear medicine and Thermal Imaging.
3. Understand the basic principles for each imaging modality.
4. Understand the concept of image Guided Intervention and image guided surgery .

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various courseoutcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various modalities.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
- Topics will be introduced in multiple representations.
- Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

X-Ray Imaging: Definition of x-ray, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors.
X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography.
Computed Tomography: Conventional tomography, Computed tomography – Projection function, CT number. Recent developments – Digital radiography, Digital subtraction angiography (DSA). Biological effects of ionizing radiation. **.(Text book 1)**

Teaching-Learning Process	Chalk and talk method, Power point presentation ,YouTube videos, Hospital visit RBT Level: L1, L2, L3

Module-2

Ultrasound Imaging: Definition of ultrasound**,** Fundamentals of acoustic propagation (only theoretical concepts, no derivations) - Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution.
Ultrasonic Diagnostic Methods: Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode). Doppler methods, Duplex imaging, Color Doppler flow imaging, Biological effects of ultrasound. **.(Text book 1)**

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit, YouTube videos RBT Level: L1, L2, L3

Module-3

Radionuclide Imaging: Introduction**,** Fundamentals of Radioactivity: Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radio nuclides, Generation & Detection of Nuclear Emission – Nuclear sources, Radionuclide generators, nuclear radiation detectors, Collimators **.**
Diagnostic Methods using Radiation Detector Probes: Thyroid function test, Renal function test, Blood volume measurement, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera, SPECT: Principle and working. PET: Principle and working. **.(Text book 1)**

Teaching-Learning Process	Chalk and talk method, Power point presentation ,YouTube videos, Hospital visit RBT Level: L1, L2, L3

Module-4

Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Relaxation times, Pulse sequences.
Generation and Detection of NMR Signal: Introduction (block diagram and working), Magnet, Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging. Biological effects of magnetic fields-Brief summary of all types of effects.**(Text book 1)**

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit, YouTube videos RBT Level: L1, L2, L3

Module-5

Thermal Imaging & Advances in Medical Imaging: Thermal Imaging: Medical Thermography, Physics of thermography, Infrared detectors, Thermographic equipment, Quantitative medical thermography, Pyroelctric vidicon camera .Applications of thermal imaging medicine **(Text book 2).**
Image Guided Intervention: Introduction, Stereotactic neurosurgery, Stereotactic neurosurgery based on digital image volumes- image acquisition, planning and transfer, Intraoperative Imaging- Intraoperative diagnostic imaging. **(Text book 3).**

Teaching-Learning Process	Chalk and talk method, Power point presentation, Hospital visit, YouTube videos RBT Level: L1, L2, L3

Course outcome (Course Skill Set)

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

1. Describe the fundamentals of x-ray radiography and computed tomography, and analyze the system requirements.
2. Explain principles of ultrasound imaging and diagnostic methods and analyze the system requirements.
3. Discuss the fundamentals of radionuclide imaging, MRI, thermal imaging and analyze the system requirements.
4. Describe the concepts of image Guided Intervention and image guided surgery.
5. Design and develop prototype of simple medical imaging 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 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4^{th} week of the semester
5. Second assignment at the end of 9^{th} 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 13^{th} week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marksand 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 themethods 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 questionpapers 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.
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:
Text Books

1. Principles of Medical Imaging - by Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.
2. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.
3. Fundamentals of Medical Imaging - by Paul Suetens, Cambridge University Press, 2002.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105091
- https://onlinecourses.nptel.ac.in/noc21_bt50/preview
- https://nptel.ac.in/courses/102105090

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

- Visit to hospitals and diagnostic centres
- Write programs to implement reconstruction algorithms

INDUSTRY 4.0 AND IIOT			
Course Code (PEC)	**21EI735**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives

- To impart basic concepts of IIoT and its implementation
- To Understand potential gains of IIoT business incentives and models
- To understand the working of IIoT through case studies
- To understand the technical issues required to build an IIoT network
- To provide business and technology participants with the information required in deploying and delivering an IIoT network.

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts IIOT.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Introduction to the Industrial Internet: Basic introduction, What Is the Industrial Internet?, The Power of 1%, Key IIoT Technologies, Why Industrial Internet and Why Now?, Catalysts and Precursors of the IIoT, Innovation and the IIoT, Intelligent Devices, Key Opportunities and Benefits, The Digital and Human Workforce
Industrial Internet Use-Cases: Healthcare, Oil and Gas Industry, Smart Office, Logistics and the Industrial

Internet, IOT Innovations in Retail.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1 and L2
Module-2	
IIoT Reference Architecture: Introduction, The IIC Industrial Internet Reference, Architecture, Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints, The Business Viewpoint, The Usage Viewpoint, The Functional Viewpoint, Implementation Viewpoint, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management, Advanced Data Analytics.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1 and L2
Module-3	
Designing Industrial Internet Systems: Introduction, The Concept of the IIoT, The Proximity Network, WSN Edge Node, WSN Network Protocols, Legacy Industrial Protocols, Modern Communication ProtocolsWireless Communication Technologies, Gateways.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1 and L2
Module-4	
Introducing Industry 4.0: Introduction, Defining Industry 4.0, Why Industry 4.0 and Why Now?, Four Main Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Industry 4.0 Reference Architecture.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1 and L2
Module-5	
Smart Factories: Introducing the Smart Factory, Smart Factories in Action, Why Smart Manufacturing Is Important, Winners and Losers?, Real-World Smart Factories, Industry 4.0: The Way Forward.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and YouTube Video Links. RBT Level: L1 and L2

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

1. Define IIoT and Industry 4.0, and list the uses of IIoT
2. Describe the IIoT architecture
3. Discuss the concepts used to design and implement IIoT.
4. Explain the need of Industry 4.0 and design principles.
5. Discuss the .development of smart factories based in IIoT and Industry 4.0 protocols.

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)**

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:
Text Books:

1. Industry 4.0: The Industrial Internet Of Things by Alasdair Gilchrist, Apress Publications, 2016

Reference Book

1. Introduction to Industrial Internet of Things and Industry 4.0 by Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 2020

Web links and Video Lectures (e-Resources):

- http://www.nitttrc.edu.in/nptel/courses/video/106105195/lec6.pdf
- https://www.academia.edu/38736167/The_Industrial_Internet_of_Things_Industry_4_0
- https://nptel.ac.in/courses/106105195

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

- Visit to modern industries
- Simulation and implementation of IIoT
- Usage of IoT, IIoT and Industry 4.0 protocols and their implementation
- Seminar / Quizzes / Assignments

UNIT OPERATIONS AND INDUSTRIAL PROCESS INSTRUMENTATION

Course Code (PEC)	**21EI741**	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 get familiarise various unit operations used in Industrial Process Control.
- To study and understand various control strategy involved in Boilers control, Furnace controls, Dryier controls, Evaporators controls, Crystallizers controls and Heat Exchangers controls.
- To understand various unit operations used in industrial plant such as cement plant, Thermal power plant, Water treatment plant and steel plant.

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

- Always start every class hour with preamble of what was covered in previous class and what would be discussed in the present class.
- Encourage group discussions and arrange debate on certain topics.
- Try to arrange some industrial visit to understand various process automation techniques.
- Give exhaustive assignments on all topics so that students will be able to practice answering any questions in the University examinations that would come from nook and corner of the syllabus.
- Arrange seminars by the students on certain intriguing topics relevant to syllabus by the students.

Module-1

Boiler Control: Boiler -pressure controls, Fuel controls, Fuel -Air ratio controls and feed water controls
Furnace Controls: Control system functions, Combustion Air requirements, control system and Instrumentation for Start-up heaters, Fired Re-boilers, Process heaters and Vaporizers.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-2

Dryers Controls: Drying of Solids, Dryer types, control of batch dryers, control of continues dryers, turbo dryers and spray dryers.
Evaporators controls: Evaporators terminology, Types of evaporators, Control systems for evaporators such as Feedback control, Case cade control, Selective control and Feed-Forward control.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-3

Crystallizers Controls: Crystallization process, Control of Evaporators crystallizers, Cooling crystallizers and Vacuum crystallizers.

Heat Exchanger Controls: Control of Liquid-to-Liquid Heat exchangers, Steam Heaters and condensers controls.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-4

Industrial Control Applications: Cement Plant: Objectives of Automation system, Raw mill automation, Kiln automation and DCS for Cement plant.

Thermal Power Plant: Block schematic, Control Equipment and applications in Power plant automation, Diagnostic function and protection.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Module-5

Industrial Control Applications: Water Treatment plant: Block schematic, Pre-chlorination control, Ratio Control, Sludge level control and Post-chlorination control.

Steel plant: Main zones in a steel plant, Automation Strategy, Iron zone controls, Blast furnace controls and Steel zone controls.

Teaching-Learning Process	Chalk and Talk Method / Power point presentation RBT levels: L1, L2 and L3

Course outcome (Course Skill Set)

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

1. Understand basic concepts of various unit operations enlisted in the syllabus.
2. Have thoroughly understanding of process involved in various industrial process such as cement plant, Thermal power plant, Water treatment plant and steel plant.
3. As students are well equipped with thoroughly understand of both unit operation and industrial process, their will be job opportunities in those various process plants.

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)**

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. Process control by Bela. G. Liptak, Instrument Engineers and book 3rd edition.
2. Computer base Industrial control by Krishnkanth PHI. New Delhi.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- https://nptel.ac.in/courses/103103155

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

- Quizzes
- Assignment
- Seminars

INSTRUMENTATION BUSES & INDUSTRIAL DATA NETWORKS			
Course Code (PEC)	21EI742	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:

This course will enable the students to:

1. Explain basic concepts of Industrial Data communication.
2. Apply network data communication protocols.
3. Solve the problems of industrial data communication systems including Modbus, Fiber optics, Industrial Ethernet etc
4. Evaluate appropriateness of different industrial data networks.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- 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.
- Topics will be introduced in multiple representations.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1	
Introduction to industrial data communications: Introduction, Modern instrumentation &control systems, Open system interconnection (OSI) model, protocols, standards-EIA-232interface standard, EIA-485 interface standard, fibre optics, Data Highway plus/DH485,foundation field bus. **Overall methodology**: Common problems &solutions, General comments on trouble shooting, A specific methodology, Grounding/shielding and noise.	
Teaching-Learning Process	Chalk and talk method, Power point presentation RBT Level: L1, L2, L3
Module-2	
Fiber Optics Overview: Introduction, Fiber optic cable components, Fiber optic cable parameters, Basic cable types, connecting fibers, splicing trace/organizers and termination cabinets, troubleshooting. **Data Highway Plus/DH485 Overview :** Allen Bradley Data Highway (plus) protocol, troubleshooting.	
Teaching-Learning Process	Chalk and talk method, Power point presentation,. RBT Level: L1, L2, L3
Module-3	
Modbus overview :Modbus protocol structure, function codes, Trouble shooting ,Profibus PA/DP/FMS overview, Profibus Protocol stack, Profibus communication model, relationship between application process and communication, communication objects, system operation, Trouble shooting. **Modbus Plus Protocol Overview:** General Overview, Trouble shooting.	
Teaching-Learning Process	Chalk and talk method, Power point presentation RBT Level: L2, L3, L4
Module-4	
HART overview : Introduction to HART and smart instrumentation, HART protocol, physical layer, Data link layer, Application layer, Trouble shooting. **TCP/IP overview :** Introduction, Internet layer protocols, Host-to-host layer, Troubleshooting.	
Teaching-Learning Process	Chalk and talk method, Power point presentation RBT Level: L2, L3, L4
Module-5	
Foundation Fieldbus Overview: Introduction, The Physical layer and wiring rules, The Data link layer, The application layer, The User layer, Error Detection and diagnostics, HSE, Good wiring and installation practice with Fieldbus, , Trouble shooting **Industrial Ethernet overview** : Introduction10Mbps Ethernet, 100 Mbp's Ethernet, **Radio and wireless communication**: Introduction, components of radio link, The radio spectrum and frequency allocation, Radio Modems.	
Teaching-Learning Process	Chalk and talk method, Power point presentation, Industrial visit RBT Level: L3, L4, L5
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Understand the basic concepts of Industrial communication system. 2. Describe the main features of fiber optic cabling & Data Highway Plus. 3. List the main Modbus structure and frames used and fixing the problems by using ProfiBus. 4. Describe the operation of HART and TCP/IP. 5. Develop the various communication networks for 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**)

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 semesterTwo

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 **20Marks** (**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 marksand 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 themethods 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 questionpapers 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 amaximum 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:
Text Books:

1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, 'Practical Industrial Data networks Design, Installation and Troubleshooting', Newnes publication, Elsevier First edition, 2004

Reference Books:

1. Andrew S. Tanenbaum, Modern Operating Systems, Prentice Hall of India Pvt. LTD, 2003
2. Stallings, W., "wireless Communication and networks", 2nd Edition, Prentice Hall of India, 2005
3. Process Software and Digital Networks", B.G. Liptak, CRC Press ISA- The Instrumentation, Systems, and Automation Society.
4. Theodore S. Rappaport, 'Wireless communication: Principles & Practice',2nd Edition,2001, Prentice Hall of India.

Web links and Video Lectures (e-Resources):

- VTU e-shikshana programme
- VTU Edu-sat programmes
- http://www.interfacebus.com/Design_Connector_Field_Buses.html
- https://www.chemicalprocessing.com/assets/Media/MediaManager/texasinstruments_fielbus.pdf
- **https://www.ti.com/applications/industrial/industrial-communications.html**

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

- Visit to modern industries
- Quizzes
- Assignment
- Seminars

DIGITAL IMAGE PROCESSING			
Course Code	**21EI743**	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:

- Understand the fundamentals of digital image processing
- Understand the image enhancement techniques in spatial domain used in digital image processing
- Understand the frequency domain enhancement techniques in digital image processing
- Understand the Color Image Processing and Image segmentation Techniques in digital image processing
- Understand the image restoration techniques and methods used in digital image processing

Teaching-Learning Process (General Instructions)

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

- Show Video/animation films to explain the functioning of various image processing concepts.
- Encourage cooperative (Group) Learning through puzzles, diagrams, coding etc., in the class.
- Encourage students to ask questions and investigate their own ideas helps improve their problem-solving skills as well as gain a deeper understanding of academic concepts.
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes criticalthinking
- Students are encouraged to do coding based projects to gain knowledge in image processing.
- 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.
- Topics will be introduced in multiple representations.
- Discuss how every concept can be applied to the real world - and when that's possible, it helpsimprove the students' understanding.
- Arrange visits to nearby PSUs such as CAIR(DRDO), NAL, BEL, ISRO, etc., and small-scale software industries to give industry exposure.

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.

[Text 1: Chapter 1, Chapter 2: Sections 2.1 to 2.5]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Videos on Imageprocessing applications Practical topics: Problems on Basic Relationships Between Pixels. **RBT Level:** L1, L2, L3

Module-2

Image Enhancement in Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters

[Text 1: Chapter 3: Sections 3.2 to 3.6]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos and animations ofIntensity Transformation Functions, Histogram Processing, Spatial domain filters. Practical topics: Problems on Intensity Transformation Functions, Histogram, Spatialdomain filters **RBT Level:** L1, L2, L3

Module-3

Image Enhancement in Frequency Domain: Basic properties of 2-D DFT, Basics of Filtering in the Frequency Domain, Image Smoothing and ImageSharpening Using Frequency Domain Filters.

[Text 1: Chapter 4: Sections 4.7 to 4.9]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on frequency domain filtering. Practical topics: Problems on Image smoothing and sharpening **RBT Level:** L1, L2, L3

Module-4

Color Image Processing: Color Fundamentals, Color Models, Pseudo-color Image Processing.
[Text 1: Chapter 6: Sections 6.1 to 6.3]
Image Segmentation: Fundamentals, Point detection, Line detection, Edge models, Edge detection, Canny edge detector. Thresholding, Region based segmentation.
Text: 10.1, 10.2.1 – 10.2.6, 10.3, 10.4

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on Color imageprocessing Practical topics: Problems on Region based segmentation **RBT Level:** L1, L2, L3

Module-5

Restoration: A model of the Image Degradation/Restoration Process, Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering.
[Text 1: Chapter 5: Sections 5.1, to 5.4.3, 5.7, 5.8]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on Noise models,filters and its applications. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)
At the end of the course the student will be able to:
1. Understand image formation and the role of human visual system plays in perception of gray andcolor image data.
2. Apply image processing techniques in spatial domains.
3. Apply image processing techniques in frequency (Fourier) domains.
4. Conduct independent study and analysis of Image Enhancement techniques.

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 semesterTwo

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 **20Marks** (**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 marksand 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 themethods 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 questionpapers 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 amaximum 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:
Text Book:

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

Reference Books:

1. Digital Image Processing- S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2014.
2. Fundamentals of Digital Image Processing- A K Jain, PHI Learning Private Limited 2014.

Web links and Video Lectures (e-Resources)

- Image databases, https://imageprocessingplace.com/root_files_V3/image_databases.htm
- Student support materials, https://imageprocessingplace.com/root_files_V3/students/students.htm
- NPTEL Course, Introduction to Digital Image Processing, https://nptel.ac.in/courses/117105079
- Computer Vision and Image Processing, https://nptel.ac.in/courses/108103174
- Image Processing and Computer Vision – Matlab and Simulink,
- https://in.mathworks.com/solutions/image-video-processing.html

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

- Simulink models for Image processing

NEURAL NETWORK AND FUZZY LOGIC SYSTEMS			
Course Code (PEC)	**21EI744**	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: This course will enable students to:

- Preparation: To prepare students with fundamental knowledge and comprehensive understanding of artificial neural networks and Fuzzy Logic systems.
- Core Competence: To equip students to develop and configure ANNs with different types of learning algorithms and to understand the basics of Fuzzy logic operations and systems for real world problems.
- Professionalism & Learning Environment: To inculcate an engineering student an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career.

Teaching-Learning Process (General Instructions)
The sample strategies, which the teacher can use to accelerate the attainment of the various course outcomes are listed in the following:

- Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
- Show Video/animation films to explain the functioning of various techniques.
- Encourage collaborative (Group) Learning in the class
- Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction. - 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	Chalk and talk method, PowerPoint Presentation, YouTube videos, Animation of basic model of a neuron in comparison of biological neuron. **RBT Level:** L1, L2, L3
Module-2	
Hebb Network and simple problems, **Supervised Learning Network – Introduction** –Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos, Animation of supervised learning algorithms. Problems on Hebb network. **RBT Level:** L1, L2, L3
Module-3	
Back –Propagation Network. - Theory, Architecture, Flowchart for training process, Training 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	Chalk and talk method, Power Point Presentation, YouTube videos Self-study topics: Architecture, Flowchart, Training and Testing algorithm. **RBT Level:** L1, L2, L3
Module-4	
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	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Module-5	
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	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Course outcome (Course Skill Set) At the end of the course the student will be able to : 1. Compare and contrast the biological neural network and ANN. 2. Discuss the ANN for pattern classification. 3. Develop and configure ANN's with different types of functions and learning algorithms. 4. Apply ANN for real world problems. 5. Discuss the fundamentals of fuzzy logic, implementation and their functions 6. Apply fuzzy logic concepts in building automated 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)**

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:

Text Books

1. S. N. Sivanandam and S.N. Deepa, "Principles of Soft Computing", 2nd Edition, Wiley India Pvt. Ltd.-2014.
2. Timothy J. Ross, "Fuzzy logic with engineering applications", McGraw Hill International Edition, 1997

Reference Books:

1. Simon Haykin, "Neural Networks: A comprehensive foundation", 2nd Edition, PHI, 1998.

Web links and Video Lectures (e-Resources):

1. http://www.nptel.ac.in/courses/106105152/
2. https://nptel.ac.in/courses/106/106/106106139

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

Numerical problems, Programming Assignments / Mini Projects can be given to improve programming skills

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING			
Course Code (PEC)	**21EI745**	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 the basics of Artificial intelligence and concepts of natural language processing.
- To learn the working of Parallel, Distributed and connectionist models of AI.
- To learn the fundamentals of Genetic algorithms.
- To understand the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised learning.
- To Explore the associated parameters of the Machine Learning algorithms viz., dimensionality

reduction, classification, etc.

Teaching-Learning Process (General Instructions)

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop student's theoretical and programming skills.
2. State the need for learning Programming with 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-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).
- As a model solution of some exercises (post-lecture activity).

Module-1

Artificial Intelligence: The AI Problems, the underlying Assumption, what is an AI technique? (Text 1- 1.1,1.2,1.3)
Natural Language Processing: Introduction, Steps in the Process. (Text 1- 15.1,15.1.1)

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-2

Parallel and Distributed AI: Psychological Modeling, Parallelism in Reasoning Systems, Distributed Reasoning Systems: Coordination and Cooperation. (Text1-16.1,16.2,16.3,16.3.1)
Connectionist Models: Introduction: Hopfield Networks, Connectionist AI and Symbolic AI. (Text 1- 18.1,18.6)

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-3

Genetic Algorithms (Gas): Learning: Generalization of an Input-Output table, Significance of the Genetic operators, Ant Algorithms. (Text 1- 23.2,23.2.2,23.3,23.8)
Multilayer Perceptrons: The Perceptron, multilayer Perceptrons, Learning time – Time delay networks, Recurrent networks, Deep Learning. (Text 2-11.1.2,11.2,11.5,11.12,11.13)

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-4

Machine Learning: Introduction, Examples of Machine learning Applications.
Supervised Learning: Learning a class from examples, Noise, Learning Multiple classes, Regression, Model selection and Generalization, Dimensions of a supervised Machine learning Algorithm. (Text 2- 1.1,1.2,2.1,2.4,2.5,2.6,2.7,2.8)

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-5

Dimensionality Reduction: Introduction, Subset selection, Principal Component analysis. Kernel Machines: Introduction, Optimal separating hyperplane (SVM). (Text 2- 6.1,6.2,6.3,13.1,13.2)

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Course outcome (Course Skill Set)

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

1. Appraise the basics of Artificial intelligence and concepts of natural language processing.
2. Illustrate the working of Parallel, Distributed and connectionist models of AI.
3. Discuss the fundamentals of Genetic algorithms.
4. Escalate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised learning.
5. Explore the associated parameters of the Machine Learning algorithms viz., dimensionality

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)**

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:

Text Books

1. Artificial Intelligence – Elaine Rich, Kevin Knight, Shivashankar B Nair, McGraw Hill Education, 3rd Edition, 2016.ISBN 978-0-07-008770-5.
2. Introduction to Machine Learning – Ethem Alpaydin, PHI Learning,3rd Edition,2018. ISBN 978-81-203-5078-6.
3. Introduction to Artificial Intelligence – Eugene Charnik, Drew McDermott, Pearson Education India, 1st edition, ISBN - 978-8131703069

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

- To implement Artificial Intelligence and Machine Learning algorithms using recent tools.

MEDICAL INSTRUMENTATION			
Course Code (OEC-II)	**21EI751**	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 provide the fundamental knowledge of Bio-medical Instrumentation,
- To impart the technology associated with the measurement of biological variables such as pressure, temperature etc related to human body,
- To understand the complexities associated with the measurement of the biological parameters and the

care that are to be taken for the measurement since it is concerned with human life.

Teaching-Learning Process (General Instructions)

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

- In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
- Show videos/animations to explain the fundamental concepts and working of medical instruments/ transducers.
- Encourage collaborative (Group) learning in the class.
- Ask higher order thinking questions in the class, which promotes critical thinking.
- 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.
- Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
- Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
- Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Fundamentals of Biomedical Instrumentation: Sources of biomedical signals, Basic Medical Instrumentation system, Interfacing analog signals to microprocessors. PC based medical instruments, General constraints in design of biomedical instrumentation systems.

Bioelectric Signals and Electrodes: Origin of Bioelectric signals, Types of bioelectric signals-ECG, EEG, EMG, Recording electrodes: Electrode – Tissue interface, polarization, skin contact- impedance, Silver-silver chloride electrodes, Electrodes for ECG (limb electrodes, floating electrodes, pregelled disposable electrodes), EEG, EMG, Microelectrodes.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation, Animations and YouTube videos RBT Level: L1, L2

Module-2

Electrocardiograph: Physiology of the heart, Electrical activity of the heart and Electrocardiogram (ECG), Normal & Abnormal cardiac Rhythms, Block diagram-description of an Electrocardiograph, ECG leads, Effects of artifacts on ECG Recordings, Multichannel ECG Machine.

Electroencephalograph: Block diagram description of an Electroencephalograph, 10-20 electrode systems, computerized analysis of EEG.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation, Animations and YouTube videos RBT Level: L1, L2

Module-3

Patient Monitoring System: Bedside patient monitoring systems, Central monitors, Measurement of heart rate – Average heart rate meter, Instantaneous heart rate meter, Measurement of pulse rate.

Blood Pressure Measurement: Introduction, Indirect methods of blood pressure measurement: Korotkoff's method, Rheographic method, differential auscultatory technique.

Measurement of Respiration Rate: Impedance pneumography, CO_2 method of respiration rate measurement, Apnoea detectors.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation, Animations and YouTube videos RBT Level: L1, L2

Module-4

Blood Flow Measurement: Electromagnetic blood flow meter- Principle and Square wave electromagnetic flowmeter. Doppler shift blood flow velocity meter, Blood flow measurement by Doppler imaging, NMR blood flowmeter.

Cardiac Pacemakers: Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable pacemakers, Programmable pacemakers.

Cardiac Defibrillator: Need for a Defibrillator, DC defibrillator, Pacer-Cardioverter-Defibrillator.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation, Animations and YouTube videos RBT Level: L1, L2

Module-5

Therapeutic Instruments:

Cardiac-assist devices, Pump oxygenators, Total artificial heart, Haemodialysis, Ventilators, Infant incubators, Drug infusion pumps.

Patient Safety: Electric shock hazards, Leakage currents, Electrical safety analyzer, Testing of Biomedical equipment.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation, Animations and YouTube videos RBT Level: L1, L2

Course Outcome: After studying this course, students will able to:

1. Acquire knowledge about origin of bio-potential, bio-signals and their measurement
2. Describe the problem, identify and formulate solution in the field of Bio-Medical Engineering for current and future issues
3. Describe the cardiac, brain and muscular physiological systems with the related diagnostic measurement methods.
4. Recognize the therapeutic methods of treatment and the associated instrumentation.
5. Identify and judge patient safety issues related to biomedical instrumentation.
6. Describe the principle and working of cardiac pacemakers, defibrillators, BP measurement, blood flow meters, CO_2 measurement, respiration measurements and their implementation.

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)**

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:

Text Books:

1. Handbook of Biomedical Instrumentation - R.S.Khandpur, 2nd Edition, Tata McGraw- Hill, 2003 (Module 1, 2, 3, 4 & Module 5- Patient Safety).
2. Medical Instrumentation: Application and Design – John G Webster, 3rd Edition, John Wiley & Sons, 2006. (Module 5- Therapeutic Instruments)

Reference Book:

1. Biomedical Instrumentation & Measurement - Leslie Cromwell, Fred J Weibell& Erich A Pfeiffer, 2nd Edition, Prentice Hall of India, 2001.

Web links and Video Lectures (e-Resources):

- https://lecturenotes.in/subject/27/biomedical-instrumentation-bi/video
- https://www.electrical4u.com/introduction-to-biomedical-instrumentation/

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

- Visit to local hospitals to see the functioning of variety of biomedical instruments and their use.
- Interaction with doctors and medical technicians to know the developments in the field of medical instrumentation.

ROBOTICS AND INDUSTRIAL AUTOMATION			
Course Code (OEC-II)	**21EI752**	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:

Preparation: To prepare students with fundamental knowledge and comprehensive understanding of basic components of robot system and industrial automation.

Core Competence: To equip students to analyze the functions of sensors in the robot, robot kinematic and evaluate the functions of robots in industrial applications.

Professionalism & Learning Environment: To inculcate an engineering student an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various learning algorithms.
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. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
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

Fundamentals of Robotics & Automation: Automation and robotics, history of robotics, robotics market and future prospects, robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot programming and work cell control, robot applications [Textbook-1]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on history of robots. **RBT Level:** L1, L2, L3

Module-2

Robot Motion Analysis, Sensors and Control: Introduction to manipulator kinematics, homogeneous transformations and robot kinematics, configuration of a robot controller, types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems.

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors. [Textbook-1]

Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, YouTube videos on robot motion. **RBT Level:** L1, L2, L3

Module-3

Machine Vision, Robot Programming & Artificial Intelligence: Introduction to machine vision, sensing and digitizing function in machine vision, image processing and analysis, Robot Programming: Lead -through programming methods, capabilities and limitations of lead-through method.

Artificial Intelligence (AI): Introduction & goals of AI in research, AI techniques, LISP programming, AI & robotics, LISP in factory, robotic paradigms. [Textbook-1]

Teaching-Learning Process	.Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Module-4	
Robotics in Manufacturing/Automation , Material Transfer, Machine Loading/Unloading: Robot cell layouts, multiple robots and machine interference, considerations in work -cell design, work-cell control, interlocks, error detection and recovery, work -cell controller, robot cycle time analysis. **Material Transfer, Machine Loading/Unloading:** General considerations in robot material handling, material transfer applications, machine loading and unloading. [Textbook-1]	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Module-5	
Robots in Automatic Processing Operations, Assembly & Inspection: Introduction, spot welding, continuous arc welding, spray coating, other processing operations. Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote center compliance (RCC) device, assembly system configurations, adaptable programmable assembly system, designing for robotic assembly, inspection automation. [Textbook-1] **Autonomous Mobile Robots: Introduction, Planning &Navigation:** Introduction, basic control scheme for mobile robots (only basic understanding of perception, localization, path planning & motion control). [Textbook-2]	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Explain the key components of robotic technologies for industrial applications.
2. Explain various sensors in Robots.
3. Describe the spatial transformation of robot joints
4. Acquire knowledge in kinematic motion of Robots.
5. Acquire the technical concepts of industrial 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 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)**

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:

Text Books

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

Reference Books:

1. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112105249
- https://nptel.ac.in/courses/112101098

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

- Programming Assignments / Mini Projects can be given to improve programming skills
- Use robotic kit to develop mini robots
- Visit to industries to see the working robot based automation

SMART SENSORS

Course Code (OEC-II)	**21EI753**	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 the principle of smart sensors and process of micromachining in development of smart sensors.
- To learn intelligent systems by interfacing the smart sensors to MCUs and DSPs.
- To analyze the use of smart sensors in communication, MEMS and automation.
- To evaluate the standards of smart sensors by the assessment of reliability testing and packaging.
- To understand the applications of smart sensors in different fields and recent development.
- To design the simple models of intelligent instrumentation.

Teaching-Learning Process (General Instructions)

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop student's theoretical and programming skills.
2. State the need for learning Programming with 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-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).
- As a model solution of some exercises (post-lecture activity).

Module-1

Basics of smart sensors and micromachining: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-2

MCUs and DSPs for sensor: Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-3

Sensor Communication and MEMS: Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors - sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-4

Packaging, Testing and Reliability of Smart Sensors: Introduction, Semiconductor packaging applied to sensors, hybrid packaging, packaging for monolithic sensors, reliability implications, testing smart sensors. Unit Standards for Smart Sensors: Introduction, setting the standards for smart sensors and systems , IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Module-5

Implications of Smart Sensor Standards and Recent Trends: Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

Course outcome (Course Skill Set)

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

1. Describe the principle of smart sensors and process of micromachining in development of smart sensors.
2. Develop intelligent systems by interfacing the smart sensors to MCUs and DSPs.
3. Analyze the use of smart sensors in communication, MEMS and automation.
4. Evaluate the standards of smart sensors by the assessment of reliability testing and packaging.
5. Discuss the applications of smart sensors in different fields and recent development.
6. Develop/sketch the simple models of intelligent instrumentation.

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)**

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. Understanding Smart Sensors- Randy Frank, 2nd Edition. Artech House Publications, 2013.
2. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. K. Aatre, Micro and Smart Systems: Technology and modeling, Willey Publications,2012.

Web links and Video Lectures (e-Resources):

- Introduction to Microscale Sensors or MEMS: https://www.youtube.com/watch?v=gG5a_zIiiV0
- MEMS :https://www.youtube.com/watch?v=CNmk-SeM0ZI
- MEMS ACCELEROMETER : https://www.youtube.com/watch?v=eqZgxR6eRjo
- MICROMACHINING OVERVIEW: https://www.youtube.com/watch?v=EALXTht-stg
- Chip Manufacturing - How are Microchips made?
- https://www.youtube.com/watch?v=bor0qLifjz4
- HOW SENSORS ARE ENABLING INDUCSTRY 4.0:https://www.youtube.com/watch?v=wKXe-0ocyiQ

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

- To learn recent tools to simulate MEMS and other sensors

MEMS AND MICROSYSTEMS			
Course Code (OEC-II)	**21EI754**	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:

Preparation: To prepare students with fundamental knowledge/ overview in the field of Micro Electro Mechanical Systems.

Core Competence: To equip students with a basic foundation in electronic engineering, mechanical engineering, electrical engineering, chemistry, physics and mathematics fundamentals required for comprehending the operation and application of MEMS circuits, design.

Professionalism & Learning Environment: To inculcate in students an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various learning algorithms.
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. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
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

OVERVIEW OF MEMS AND MICROSYSTEMS: MEMS & Microsystems, Typical MEMS and Micro system Products, Evolution of Micro fabrication, Microsystems and Microelectronics. The Multidisciplinary nature of Microsystem, Design and Manufacture, Microsystem and Miniaturization, Applications of Microsystems in the Automotive Industry and in other industries.

Teaching-Learning	Chalk and talk method, PowerPoint Presentation.

Process	**RBT Level:** L1, L2, L3
Module-2	
WORKING PRINCIPLES OF MICROSYSTEMS: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers Micro fluids. **Engineering Science for Microsystems Design and Fabrication**: Introduction, Atomic Structure of Matter, Ions and Ionization Molecular Theory of Matter and Intermolecular Forces, Plasma Physics, Electrochemistry.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Module-3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, **MATERIALS FOR MEMS AND MICROSYSTEMS:** Introduction, Substrates and wafers, Active Substrate materials, silicon as a substrate material, silicon compounds and silicon piezoresistors.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Module-4	
MICROSYSTEMS FABRICATION PROCESS: Introduction, Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour deposition, Deposition by Epitaxy, Etching. **MICROSYSTEMS DESIGN:** Introduction, Design considerations, Process Design, Design of a silicon Die for a Micro pressure sensor, Design of Micro fluidic network systems.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3
Module-5	
MICROSYSTEMS PACKAGING: Introduction, Overview of Mechanical Packaging of Microelectronics, Micro system Packaging, Interfaces in Micro system Packaging, Essential Packaging Technologies, Three-dimensional Packaging, Assembly of Microsystems, Selection of Packaging Materials, Signal Mapping and Transduction, Design Case: Pressure Sensor Packaging.	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

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

1. Understand the technologies related to Micro Electro Mechanical Systems.
2. Understand design and fabrication processes involved with MEMS devices.
3. Analyse the MEMS devices and develop suitable mathematical models
4. Know various application areas for MEMS device.

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)**

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 **MEMS & Microsystems Design and Manufacture** – Tai Ran Hsu, TMH 2002.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117105082
- https://nptel.ac.in/courses/108108113
- https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/BIOMEMS-MODULE1.pdf

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

- Develop mini projects and Final year projects using MEMS components to address the real world problems

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Electronics and Instrumentation Engineering

NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the Academic Year 2021 - 22)

VIII SEMESTER

TECHNICAL SEMINAR			
Course Code (Seminar)	**21EI81**	CIE Marks	100
Contact Hours/Week	01	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	01	Exam Hours	

RESEARCH INTERNSHIP/INDUSTRY INTERNSHIP			
Course Code (INT)	**21INT82**	CIE Marks	100
Contact Hours/Week	02	SEE Marks	100
Total Hours of Pedagogy	--	Total Marks	200
Credits	15	Exam Hours	03

NATIONAL SERVICE SCHEME (NSS) / PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS) / YOGA			
Course Code (NCMC)	**21NS83/21PE83/21YO83**	CIE Marks	50
Contact Hours/Week	--	SEE Marks	50
Total Hours of Pedagogy	--	Total Marks	100
Credits	--	Exam Hours	--