Semester | 5

V Semester

Technological Innovation Management & Entrepreneurship			Semester	V
Course and Course Code	HSMS	**BEI501**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:

After completion of the course, the students will be able 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)

These are sample Strategies; that 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.
- 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, You Tube Videos, Power Point Presentation.
RBT Levels	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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L2, L3
MODULE – 3	
Leadership-Meaning, Characteristics, Behavioural 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE – 4	
Entrepreneurship: Introduction, Evolution of the concept of Entrepreneurship, Entrepreneurship today, Types of Entrepreneurs, Entrepreneurship, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
Course outcomes (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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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 Books

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

- Quizzes,
- Assignments,
- Seminars

Process Instrumentation			Semester	V
Course and Course Code	IPCC	**BEI502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0		SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots		Total Marks	100
Credits	4		Exam Hours	3
Examination nature (SEE)	Theory with Practical			

Course objectives:

After completion of the course, the students will be able to

- Distinguish the types of sensors
- Have the knowledge of I/O measuring instruments and their principle of operation
- 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.
- Understand the application of different sensors in Process Industries
- Monitor Process control Instruments

Teaching-Learning Process (General Instructions)

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

- 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 debates on selected topics.
- Try to arrange some industrial visits 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

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 method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

MODULE – 2

Temperature Measurement

Standards and calibration, thermal expansion methods, bimetallic thermometers, liquid in glass thermometers, pressure thermometers, Thermo Electric sensors (Thermocouples), Reference junction considerations, special materials, configurations and Techniques, Junction semiconductor sensors, Digital thermometers.

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

MODULE – 3

Pressure Measurement:
Basic principle of pressure Measurement, Diaphragms, Flat and corrugated diaphragms, capsules, Bourdon tubes, Bellows. Force balance pressure Transducer, Solid state Needle pressure Transducer, Thin film pressure Transducer, Digital pressure Transducer, piezoelectric pressure Transducer, Pressure Multiplexer, Pressure calibration

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

MODULE – 4

Flow Measurement:
Classification of Flow Meters, Head type flow meters, Rotameters, Electromagnetic Flow Meters, Mechanical Flow Meters, Anemometers, Ultrasonic flow meters, Votex flow meters

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

MODULE – 5

Level Measurement:
Capacitance probe, conductivity probes, Diaphragm level detector, Differential pressure level detector. Radiation level sensors, Level Transmitters, Ultrasonic level detector.

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

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

Sl. No	**List of experiments to be performed**
1	Study of classification of Instruments on Null and Deflection methods
2	Methods of correction for interfering and modifying inputs
3	Current to Voltage conversion and vice versa.
4	Pressure to Current & Current to Pressure Convert or using real time process trainer.
5	Study of Control Valve characteristics.
6	To study the action of Flow process using ON-OFF control
	Following experiments to be done using the Simulation Platform
7	Design of cascade and feed-forward controller in a simulation platform.
8	Data Acquisition and control using a simulation platform
	Demo experiments for CIE
9	Realize the response of the first-order system. plot the output response
10	Realize the response of the second order system for critical damped over damped and under damped system. plot the output response.
11	Realize proportional-integral mode control using the analog controller and plot the output response

12	Realize proportional- derivative mode control using the analog controller and plot the output response

Course outcomes (Course Skill Set):

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

- Each graduate will understand the physics of pressure measurement
- Explain the basic principles & importance of process control in industrial process plants
- Explain the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants;
- Summarize various sensor measurement techniques
- Analyze a suitable instrumentation system for various 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks - 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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.
4. Marks scored by the student shall be proportionally scaled down 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 may include questions from the practical component.

Suggested Learning Resources:

Text Books

1) Measurement systems application and design- ERNEST O DOEBELIN, 5th Edition Tata McGraw Hill.
2) Instrument Engineers Hand book-(process measurement) B G LIPTAK, Chilton book Company.

Reference Books

1) Instrumentation Devices & Systems- Rangan, Mani and Sharma 2nd Edition, Tata McGraw Hill.
2) Process Instruments & Controls Hand Book Considine- D.M. Mc Graw Hill.
3) Transducers & Instrumentation- DVS Murthy, Prentice Hall of India.
4) Instrumentation & Process Measurements- W.Bolton, universities Press

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

- Quizzes,
- Assignments,
- Seminars

Digital Signal Processing			Semester	V
Course and Course Code	PCC	**BEI503**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	4		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- To learn the basic concepts and properties of discrete-time signals and systems.
- To learn the frequency domain characteristics of discrete-time signals and systems.
- To design and implement digital filter design techniques
- It will provide knowledge of Digital filter.

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

- These are sample Strategies, which teachers 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 debates on selected topics.
- 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: Signals and systems, Basic elements of Digital Signal Processing (DSP), analog to digital conversion (ADC), comparison between DSP and Analog Signal Processing (ASP) with applications of DSP. Discrete-time signals and systems: classification of signals, sampling process/theorem, aliasing effect and reconstruction, Classification of systems, input-output description of systems, Block-diagram representation of discrete-time systems.

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

MODULE – 2

Analysis of discrete-time systems: Linear convolution, causality and stability of discrete time systems, autocorrelation, cross correlation, z-transform and its properties, solving difference equations and analysis of discrete-time systems in z-domain, transfer function, pole-zero plot.

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

MODULE – 3

Frequency analysis of discrete-time signals: Frequency response of LTI systems, ideal frequency selective filters, magnitude and phase response, Discrete-time Fourier Series, Properties of DFS, The Discrete Time Fourier Transform (DTFT), symmetry properties and theorems of DTFT. Energy density spectrum and power density spectrum.

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

MODULE – 4	
Discrete Fourier Transform (DFT): Introduction, Properties of DFT, symmetry properties, circular convolution, linear filtering methods based on DFT, Frequency analysis of signals using DFT, Efficient computation of DFT, Fast Fourier Transform (FFT) algorithms: radix-2 decimation-in-time (DIT) and decimation-infrequency (DIF)FFT algorithms.	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE – 5	
Design of digital IIR filters from analog filters: Implementation of discrete-time systems: and Infinite Impulse Response (IIR) structure Introduction to analog IIR filters, Butterworth approximation, Chebyshev approximation. Design of digital IIR filter: impulse invariance method, bilinear transformation, approximation derivative method. Frequency transformations in analog and digital domain. **Design of FIR filters**: Structures for the realization, Finite Impulse Response (FIR) Introduction to FIR filters, linear phase filters, symmetric and anti-symmetric filters, FIR design by Fourier approximation, window method, frequency sampling method, comparison between FIR and IIR filters	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (Course Skill Set):

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

1) Describe signals mathematically and understand how to perform mathematical operations on signals and to differentiate Sampling conditions
2) Compute the response of discrete-time systems to various input signals.
3) Evaluate and analyze the frequency domain characteristics of discrete-time systems
4) Design and implement different frequency selective FIR and IIR filters
5) Understand the significance of various filter structures and effects

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Oppenheim A V and Sehafer R W, "Discrete Time Signal Processing", Prentice Hall (1989).
2) Proakis J G and Manolakis D G, "Digital Signal Processing", Pearson Education India.
3) Udayashankara, "Real Time Digital Signal Processing", Publisher, Prentice- Hall of India Pvt Limited, 2010. ISBN, 8120340493, 9788120340497

Reference Books

1) D Ganesh Rao and Vineeth P Gejji, "Digital Signal Processing" Cengage India Private Limited, 2017, ISBN: 9386858231
2) Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_ee20/preview
- https://nptel.ac.in/courses/117102060
- https://nptel.ac.in/courses/108104100

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

- Demonstration of Signals in Time domain and frequency domain
- Quizzes,
- Assignments,
- Seminars

Digital Signal Processing Lab			Semester	V
Course Code	PCCL	**BEIL504**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0		SEE Marks	50
Credits	1		Exam Hours	3
Examination type (SEE)	Practical			

Course objectives:

- Carryout basic signal processing operations
- Understand the concepts of analog to digital conversion of signals and frequency domain sampling of signals.
- Modeling of discrete time signals and systems and verification of its properties and results.
- Implementation of discrete computations using DSP processor and verify the results.
- Realize the digital filters using a simulation tool and a DSP processor and verify the frequency and phase response.

Teaching-Learning Process (General Instructions)

- These are sample Strategies, which teachers 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 debates on selected topics.
- 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.
- Try to arrange some industrial visit to understand various process automation techniques.

Sl.NO	Experiments using DSP kit
1	Sampling of analog signals and study of aliasing.
2	Linear and circular convolution of two given sequences, Commutative, distributive and associative property of convolution.
3	Auto and cross correlation of two sequences and verification of their properties
4	Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum (using DFT equation and verify it by built-in routine).
5	Verification of DFT properties (like Linearity and Parseval 's theorem, etc.)
6	Design and implementation of Lowpass and High pass FIR filter to meet the desired specifications (using different window techniques) and test the filter with an audio file. Plot the spectrum of audio signal before and after filtering.
7	Obtain the Linear convolution of two sequences.
8	Compute Circular convolution of two sequences.
	Demonstration Experiments on DSP kit (For CIE)
9	Audio applications such as to plot a time & frequency display of a microphone using DSP. Read a wav.file & match their respective specification
10	Noise Removal: Removal of noise using Butterworth, Chebyshev I & II order Filters i. Add noise above 3khz & remove using adaptive filters

	ii. Interference suppressions using 400Hz tone.
11	Real time implementation of an audio signal to realize & Compute the response & Store using " FPGA based Software Defined Test & Measuring Instrument – Digital Filter Box, FIR Filter Builder & Data Logger"
12	Compute the correlation coefficient for the two given audio signals of the same length using " FPGA based Software Defined Test & Measuring Instrument – Digital Filter Box & FIR Filter Builder"

Course outcomes (Course Skill Set):

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

1) Write programs using Matlab / Scilab/Octave to demonstrate the DSP concepts on sampling, convolution and correlation, and implementation of the same using DSP kit.
2) Write programs using Matlab / Scilab/Octave for generation and computation of discrete signals.
3) Write program using Matlab / Scilab/Octave to apply FFT/DFT algorithm to determine spectrum of a given signal, and implementation of the same using DSP kit.
4) Write programs using Matlab / Scilab/Octave to design and evaluate different types of low and high pass filters.
5) Design and demonstrate IIR and FIR filters using Matlab / Scilab/Octave programs and DSP Kit.
6) Design and demonstrate DSP system applications in noise cancellation, communication, biomedical signal processing.

Conduct of Practical Examination:

1) All laboratory experiments are to be included for practical examination.
2) Students are allowed to pick one experiment from the lot.
3) Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4) Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE)

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).

- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE)

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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% of Marks allotted to the procedure part are to be made zero.

Suggested Learning Resources:

1) Roberto Cristi, "Modern Digital Signal Processing", 2003, Nelson Engineering
2) Vinay K. Ingle (Author), John G. Proakis, "Digital Signal Processing Using MATLAB", 3rd Edition, CL Engineering.
3) V.Udayashankara, "Modern Digital Signal Processing", Third Edition, PHI 2016
4) John Proakis, Dimitris G Manolakis, "Digital Signal Processing Principles", Algorithms and Application", PHI, 3rd Edition (2000).
5) S K MITRA, "Digital Signal Processing", 4th Edition, McGraw-Hill.
6) Avtar Singh, S. Srinivasan, "Digital Signal Processing Implementation", Brooks Cole.
7) S. Salivahana, A.Vallavaraj, Gnanapriya, "Digital Signal Processing", McGraw-Hill, 2nd Edition (2000).

Professional Elective Subjects

Biomedical Signal Processing			Semester	V
Course and Course Code	PEC	**BEI515A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Understand and Apply Various Methods for Analyzing Biomedical Signal Characteristics
- Acquiring and preprocessing of physiological signals to extract meaningful information
- Explore Alternative Techniques of Analyzing Biomedical Signals in Time and Frequency Domain
- To Understand the Functional Elements of Biomedical Instrumentation

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

- 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 debates on selected topics.
- Try to arrange some industrial visits 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 Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals ECG, EEG, EMG, PCG, ENG, ERPS, EGG, Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

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

MODULE – 2

Signal Conversion: Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits, Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering.

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

MODULE – 3	
Wavelet and Speech Processing: Introduction to wavelets, Time frequency representation, Discrete wavelet transform, pyramid algorithm, Comparison of Fourier transform and wavelet transform, Speech analysis – Cepstrum – Homomorphic filtering of speech signals, ECG signal characteristics – EEG analysis	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE – 4	
Analysis of Bio-signals: Automatic analysis and classification of ECG, P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Signal averaged ECG, Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, Analysis of PCG signal, Analysis of EMG signal	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE – 5	
Medical Imaging Techniques: CT scan, ultrasound, NMR,PET, SPECT and X-Ray, Medical imaging modalities: X-Ray, computed tomography, Positron emission tomography, ultrasound, MRI	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (Course Skill Set):

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

1) Discuss the origin, nature and characteristics of biomedical signals.
2) Identify the noise and artifacts in biomedical signals and apply suitable filters remove.
3) Apply the signal averaging technique.
4) Evaluate various event detection techniques for the analysis of the EEG and ECG.
5) Apply different data compression techniques on biomedical Signals.
6) Develop algorithms to process and analyze biomedical signals for better diagnosis.
7) Understand the application of engineering methods for the improvement of human health

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Handbook of Biomedical Instrumentation-R. S. Khandpur, 2nd Edition, 2003, Tata McGraw-Hill
2) Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons
3) Nishimura D, Principles of Magnetic Resonance Imaging, Stanford University Press
4) Introduction to Wavelets and Wavelet Transforms- A Primer, C. Sidney Burrus, Ramesh A. Gopinath and Haitao Guo (Prentice Hall)

Reference Books

1) Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill, D.C.Reddy, 2005
2) Biomedical Digital Signal Processing-Willis J.Tompkins, PHI,
3) Biomedical Signal Processing -Cohen. A, -Vol. I Time & Frequency Analysis, CRC Press, 1986.

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

- Quizzes,
- Assignments,
- Seminars

Raspberry Pi			Semester	V
Course and Course Code	PEC	**BEI515B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Learn about the essentials of Raspberry Pi required for IoT
- Develop programming skills to make Raspberry Pi projects
- Use sensors and interface devices with Raspberry Pi
- Communicate wirelessly with other devices from distant locations

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

- 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 debates on selected topics.
- Try to arrange some industrial visits 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 Raspberry Pi: Different Models of Raspberry Pi and its importance, Peripherals of Raspberry Pi, Applications of Raspberry Pi, Future of Micro Computing, Basic functionality of Raspberry Pi board and its Processor, Setting and configuring the board, differentiating Raspberry Pi from other platforms Text Book:1

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

MODULE – 2

Introduction to Linux OS: Implications of Operating System on the behaviour of Raspberry Pi ,Overview of Linux and its terminal command, aptget update, aptget upgrade, Navigating the file system and managing the process, Text based user interface through the shell, Overview of graphic user interface.
Text Book:1

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

MODULE – 3

Introduction to Python Programming Language : Python Programming Environment, Python Expressions, Strings, Functions, Function Arguments, Lists, List Methods, Control Flow, PIP, Numpy and customized libraries. Text Book:1 & 2

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

MODULE – 4

Exploring Electronics with Raspberry Pi: I2C,SPi, UART, Working with RPiL, GPIO Library, Interfacing of Sensors and Actuators. Text Book:3

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

MODULE – 5

Communication: Wired and Wireless Communication, TCP IP Configurations, SSH, Putty terminal Usage Text Books:3

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

Course outcomes (Course Skill Set):

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

1) Create functionality of Computer by wiring Raspberry Pi
2) Use Python based IDE and debug python code
3) Implement various communication protocols for wired and wireless communication
4) Students will be introduced to understand the various concepts of Cloud & Sensor Networks

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

1) Raspberry Pi 3 #: An Introduction to Python Scratch, Java Script and more, Gary Mitnick, Create Space Independent Publishing platform
2) Raspberry Pi for Python Programmers Cookbook, Tim Cox, Packt Publishing Limited,2nd Revised Edition,2016
3) Raspberry Pi User Guide, Eben Upton and Gareth Halfacreee, John Wilsey & Sons, 2016

Web links and Video Lectures (e-Resources):

- https://opensource.com/article/19/3/resources-raspberry-pi

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

- Quizzes,
- Assignments,
- Seminars
- Micro/Mini Projects

Digital Communication			Semester	V
Course and Course Code	PEC	**BEI515C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives

After completion of the course, the students will be able to

- Understand the concept of signal processing of digital data and signal conversion to symbols at the transmitter and receiver.
- Compute performance metrics and parameters for symbol processing and recovery in ideal and corrupted channel conditions.
- Understand the principles of spread spectrum communications.
- Understand the basic principles of information theory and various source coding techniques.
- Build a comprehensive knowledge about various Source and Channel Coding techniques.
- Discuss the different types of errors and error detection and controlling codes used in the communication channel.
- Understand the concepts of convolution codes and analyze the code words using time domain and transform domain approach.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that 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.
- Arrange visits to nearby PSUs such as BHEL, BEL, ISRO, etc., and small-scale communication industries.
- Show Video/animation films to explain the functioning of various modulation techniques, Channel, and source coding.
- 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 & 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 to improve the students' understanding.

MODULE – 1

Digital Modulation Techniques: Phase shift Keying techniques using coherent detection: generation, detection and error probabilities of BPSK and QPSK, M–ary PSK, M–ary QAM. Frequency shift keying techniques using Coherent detection: BFSK generation, detection and error probability. Non coherent orthogonal modulation techniques: BFSK, DPSK Symbol representation, Block diagrams treatment of Transmitter and Receiver, Probability of error (without derivation of probability of error equation).

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

MODULE – 2

Signalling Communication through Band Limited AWGN Channels:

Signalling over AWGN Channels- Introduction, Geometric representation of signals, Gram- Schmidt Orthogonalization procedure, Conversion of the continuous AWGN channel into a vector channel (without statistical characterization), Optimum receivers using coherent detection: ML Decoding, Correlation receiver, matched filter receiver.

Signal design for Band limited Channels: Design of band limited signals for zero lSI-The Nyquist Criterion (statement only), Design of band limited signals with controlled lSI-Partial Response signals, Probability of error for detection of Digital PAM: Symbol-by-Symbol detection of data with controlled lSI.

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

MODULE – 3

Principles of Spread Spectrum: Spread Spectrum Communication Systems: Model of a Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Systems, Effect of De-spreading on a narrowband Interference, Probability of error (statement only), Some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum, CDMA based on IS-95.

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

MODULE – 4

Introduction to Information Theory: Measure of information, Average information content of symbols in long independent sequences.

Source Coding: Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon-Fano Encoding Algorithm, Huffman coding.

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes.

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

MODULE – 5

Linear Block Codes: Matrix description of Linear Block Codes, Error Detection & Correction capabilities of Linear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.

Convolution codes: Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram.

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

Course outcomes (Course Skill Set):

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

1) Analyze different digital modulation techniques and choose the appropriate modulation technique for the given specifications.
2) Test and validate symbol processing and performance parameters at the receiver under ideal and corrupted bandlimited channels.
3) Differentiate various spread spectrum schemes and compute the performance parameters of communication system.

4) Apply the fundamentals of information theory and perform source coding for given message
5) Apply different encoding and decoding techniques with error Detection and Correction.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Simon Haykin, "Digital Communication Systems", John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.
2) John G Proakis and Masoud Salehi, "Fundamentals of Communication Systems", 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.
3) K Sam Shanmugam, "Digital and analog communication systems", John Wiley India Pvt. Ltd, 1996.
4) Hari Bhat, Ganesh Rao, "Information Theory and Coding", Cengage, 2017.
5) Todd K Moon, "Error Correction Coding", Wiley Std. Edition, 2006.a

Reference Books

1) Bernard Sklar, "Digital Communications – Fundamentals and Applications", Second Edition, Pearson Education, 2016, ISBN: 9780134724058.
2) K Sam Shanmugam, "Digital and analog communication systems", John Wiley India Pvt. Ltd, 1996.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108102096

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

- Quizzes,
- Assignments,
- Seminars

Computer Communication Networks			Semester	V
Course and Course Code	PEC	**BEI515D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Identify the different types of Network
- Explain the use of Computer Network
- Learn the basics elements of data communication system
- Build an understanding of the fundamental concepts of computer networking

Teaching-Learning Process (General Instructions)
These are sample Strategies; that teachers 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 debates on selected topics.
- Try to arrange some industrial visits 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: 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, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2

MODULE – 2

The Data Link Layer: Data Link Layer Design Issues, Framing, Flow and Error Control, Error Detection and Correction, Sliding Window Protocols: Simple Protocol, Stop and Wait protocol, Piggybacking, Go back n and sliding window protocols, Protocol Verification.

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2

MODULE – 3

The Medium Access Control Sub Layer: The Channel Allocation Problem, Multiple Access Protocols: Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA., Ethernet, Wireless LANS Broadband Wireless, Bluetooth: Architecture, Layers.

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

MODULE – 4	
The Network Layer: Network Layer Design Issues, Routing Algorithms: Shortest Path Routing, Distance Vector Routing, Link State Routing, Hierarchical routing Congestion Control Algorithms: and quality of service: The Leaky Bucket Algorithm and Token Bucket Algorithm	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (Course Skill Set):

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

1) Describe the basic computer network technology.
2) Describe the layering architecture of computer networks and distinguish between the OSI reference model and TCP/IP protocol suite.
3) Identify and analyze the different network topologies and protocols. Analyze the different network devices and their functions within a network
4) Identify the protocols and services of Data link layer.
5) Construct a network model and determine the routing of packets using different routing algorithms.
6) Identify the protocols and functions associated with the transport layer services.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Computer Networks: Andrews S. Tanenbaum, 4th Edition, Pearson Education, 2010.

Reference Books

1) ATM Networks concepts and Protocols **–** SumitKasera, Tata McGraw Hill 2nd edition, 2008
2) Data and computer networks- W STALLINGS 5th Edition, Prentice Hall of India 1998.

Web links and Video Lectures (e-Resources):

- https://sites.ecse.rpi.edu/~koushik/shivkuma-teaching/video_index.html

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

- Quizzes,
- Assignments,
- Seminars

Semester | 6

VI Semester

ARM Processor			Semester	VI
Course and Course Code	IPCC	**BEI601**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	4		Exam Hours	3
Examination nature (SEE)	Theory with Practical			

Course objectives:
After completion of the course, the students will be able to

- 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; that 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 like PPT presentation through LCD maybe 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 atleast 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.
- Showthedifferentwaystosolvethesameprogramtaskandencouragethestudentstocomeupwiththeirown 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.
Text Book 1: Chapter 1: 1.1 to 1.4, Chapter 2: 2.1 to 2.5

Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 *Text Book 1: Chapter 1: 1.1 to 1.4, Chapter 2: 1.1 to 2.5*	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 Datatypes, C looping Structures Register allocation, Function calls.	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L2, L3
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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2

Practical Component of IPCC *(May cover all / major modules)*

Sl. No	List of experiments to be performed
1	Write an ALP to find the sum of first 10 integer numbers.
2	Write an ALP to find factorial of a number.
3	Write an ALP to add an array of 16- bit numbers and store the 32- bit result in internal RAM
4	Write an ALP to find the square of a number (1 to 10) using look-up table.
5	Write an ALP to find the largest/smallest number in an array of 32 numbers.
6	Write an ALP to arrange a series of 32 bit numbers in ascending/descending order using Bubble sort algorithm
7	Interface with LPC1768 ARM to Display “Hello World” message using Internal UART.

8	Interface a DAC and generate Triangular and Square waveforms.
9	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction
10	Interface and Control a DC Motor.
	Demonstration Experiments (for CIE)
11	Interface a 4x4 keyboard and display the key code on an LCD.
12	Demonstrate the use of an external interrupt to toggle an LED ON/OFF.
13	Interface a simple Switch and display its status through Relay, Buzzer and LED
14	Interface a 4x4 keyboard and display the key code on an LCD.

Course outcomes (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 Builtin Peripherals for hardware programs,
6) Design, analyse 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks - 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.

- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

Semester End Examination 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.
4. Marks scored by the student shall be proportionally scaled down 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 may include questions from the practical component.

Suggested Learning Resources:

Text Books

1) Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1stEdition, 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,

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,
- Assignments,
- Seminars
- Mini project

Process Control Systems			Semester	VI
Course and Course Code	PCC	**BEI602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	4		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able 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; that 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L3, L4 and L5
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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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. Module 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

Professional Elective Course

Robotics and Automation			Semester	VI
Course and Course Code	PEC	**BEI613A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that 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 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

MODULE – 3

Machine Vision & Artificial Intelligence: Introduction to machine vision, sensing and digitizing function inmachine 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, You Tube Videos, Power Point Presentation.
RBT Levels	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, You Tube Videos, Power Point Presentation.
RBT Levels	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, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

Course outcomes (Course Skill Set):

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

- Explain the key components of robotic technologies.
- Explain various sensors in Robots.
- Solve problems in spatial transformation
- Acquire knowledge in kinematic motion of Robots.
- 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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

Digital Image Processing			Semester	VI
Course and Course Code	PEC	**BEI613B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that teachers 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 critical thinking
- 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 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

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, You Tube Videos, Power Point Presentation.
RBT Levels	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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 Image Sharpening Using Frequency Domain Filters. [Text 1: Chapter 4: Sections 4.7 to 4.9]	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (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 and color 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

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
- Quizzes,
- Assignments,
- Seminars

Medical Imaging Techniques			Semester	VI
Course and Course Code	PEC	**BEI613C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Understand the origin of Electromagnetic radiation.
- Identify the different modalities X-ray, Ultrasound, CT, MRI, Nuclear medicine and Thermal Imaging.
- Understand the basic principles for each imaging modality.
- Understand the concept of image Guided Intervention and image guided surgery.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that 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 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, You Tube Videos, Power Point Presentation.
RBT Levels	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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
Course outcomes (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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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

- Quizzes,
- Assignments,
- Seminars

- Visit to hospitals and diagnostic centres
- Write programs to implement reconstruction algorithms

Industrial Internet of Things (IIoT)			Semester	VI
Course and Course Code	PEC	**BEI613D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that teachers 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, 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 Protocols Wireless Communication Technologies, Gateways.	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test

will be administered after 85-90% of the syllabus has been covered

- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books

1) Industry 4.0: The Industrial Internet Of Things by Alasdair Gilchrist, Apress Publications, 2016

Reference Books

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
- Quizzes,
- Assignments,
- Seminars

Open Elective Course

Measurement Instrumentation & Transducers			Semester	VI
Course and Course Code	OEC	**BEI654A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that teachers 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

Classification and Functional Elements of Instrument/ measurement system: Measurement, significance of measurement, instruments and measurement systems, mechanical, electrical and electronic instruments (Common to EIM), 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

MODULE – 2

Static and Dynamic Characteristics: Static calibration and error calibration curve, accuracy and precision, indications of precision, static error, scale range and scale span, reproducibility and drift,

repeatability, signal to noise ratio, sensitivity, linearity, hysteresis, threshold, dead zone and dead time, resolution, signal to noise ratio, factors influencing the choice of transducers/instruments. Dynamic response – dynamic characteristics, time domain analysis & different types of inputs, frequency domain analysis. 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 method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3

MODULE – 3

Measurement of Displacement: Introduction, Principles of Transduction, Variable resistance devices, variable Inductance Transducer, Variable Capacitance Transducer, Hall Effect Devices, Proximity Devices, **Digital Transducer Measurement of Level:** Capacitance probes, conductivity probes, differential pressure level detector, float level devices, optical level switches, ultrasonic level detector, thermal level sensors

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

MODULE – 4

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 characteristics only), Strain gauge Circuits – Wheatstone bride circuit, Applications.

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.

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

MODULE – 5

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, piezoelectric pressure transducer, pressure multiplexer, pressure calibration.

Miscellaneous Sensors: Noise (sound) Sensors, Speed Sensors, Thickness Measurement.

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

Course outcomes (Course Skill Set):

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

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

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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, Module 5 – Measurement of pressure)
3) Process Measurement Instrument Engineers Handbook- BelaG. Liptak, Revised Edition, Chilton Book Company, 1982. (Module 3 – Level measurement, Module 5- Miscellaneous Sensors)

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

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

- Quizzes,
- Assignments,
- Seminars

Optical Instrumentation			Semester	VI
Course and Course Code	OEC	**BEI654B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able 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; that teachers 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, You Tube Videos, Power Point Presentation.
RBT Levels	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.
(Text book-1)

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation.
RBT Levels	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.

(Text book-2)

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

Course outcomes (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.
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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at

the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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

Scientific and Analytical Instrumentation			Semester	VI
Course and Course Code	PEC	**BEI654C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that 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.
- 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 to improve 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (Course Skill Set):

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

- Understand the principle, construction and working of UV & IR spectroscopy.
- Understand the principle, construction and working of Flame Emission and Atomic Absorption Spectroscopy
- Understand the principle, construction and working of Gas & High-performance Liquid Chromatograph.
- 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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,
- Assignments,
- Seminars

Mechatronics			Semester	VI
Course and Course Code	OEC	**BEI654D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	3		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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; that teachers 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: 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 method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, 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 method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, 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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
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 **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 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.
4. Marks scored shall be proportionally reduced 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-ilovepdfcompressed.pdf
- https://nptel.ac.in/courses/112103174

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

- Quizzes,
- Assignments,
- Seminars

Process Control and Virtual Instrumentation Lab			Semester	VI
Course Code	PCCL	**BEIL606**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0		SEE Marks	50
Credits	1		Exam Hours	3
Examination type (SEE)	Practical			

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.

Teaching-Learning Process (General Instructions)

- These are sample Strategies, which teachers 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 debates on selected topics.
- 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.
- Try to arrange some industrial visit to understand various process automation techniques.

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) (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:

1) Demonstrate the skill set in designing the signal conditioning circuits for various physical variables using different types of sensors.
2) Demonstrate the skill set of programming computer based PID controllers.
3) Acquire required skill set for virtual instrumentation using lab view programming techniques.
4) 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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE)

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.

- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE)

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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% of Marks allotted to the procedure part are to be made zero.

Suggested Learning Resources:

1) Introduction to Programmable Logic Controllers, Garry Dunning, 3nd edition, Centage Learning.
2) Computer based Industrial Control, Krishna Kant, 2nd edition, PHI, 2017.
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

- www.udemi.com
- https://learn.ni.com
- https://m.youtube.com

Ability Enhancement Course / Skill Development Course V

Integrated Systems Lab			Semester	VI
Course Code	AEC	**BEI657A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0		SEE Marks	50
Total Hours of Pedagogy	12 Lab slots		Total Marks	100
Credits	1		Exam Hours	3
Examination nature (SEE)	Practical			

Course objectives:

After completion of the course, the students will be able to

- To explore various machine learning and deep learning algorithms
- To train and test the prediction model
- To develop the prediction model
- To deploy the prediction model in target devices

Sl. No	Experiments
1	Regression Analysis
2	Data classification using Various machine learning algorithms
3	Create a Simple Image Classification Network Using a Deep Network Designer
4	Development of image classification Models using Squeezenet
5	Development of an Alarm system using a Neural Network Fitting Tool
6	Deployment of Prediction Model in the target device
7	Create a system to monitor and control temperature using an Arduino, a temperature sensor (e.g., LM35), and a cooling fan
8	Develop a smart lighting system that adjusts brightness based on ambient light using an Arduino, a light sensor (e.g., LDR), and an LED
	Demonstration Experiments (For CIE)
9	Create an automated plant watering system using an Arduino, a soil moisture sensor, and a water pump.
10	Create a system to monitor temperature and humidity using an Arduino, DHT11 sensor, and an LCD display
11	Detect an object using an IR sensor with Simulink programming.
12	Temperature measurement using Simulink

Course outcomes (Course Skill Set):

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

- Use various machine learning and deep learning algorithms in engineering applications
- Train and test the prediction model
- Use the developed prediction model in the simulation environment
- To deploy and test the prediction model in target devices like Arduino / Raspberry pi

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability**.**
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- Breakup (Rubrics) 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 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% of Marks allotted to the procedure part are to be made zero.

Suggested Learning Resources:

Text Books

1) Abhishek Kumar Pandey, Pramod Singh Rathore, Dr. S. Balamurugan, A Practical Approach for Machine Learning and Deep Learning Algorithms, BPB publications, India

Reference Books

1) Phil Kim, MATLAB Deep Learning With Machine Learning, Neural Networks and Artificial Intelligence, A Press, New york, 2017

Web links and Video Lectures (e-Resources):

- https://in.mathworks.com/

Java Programming			Semester	VI
Course Code	AEC	**BEI657B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:1:0:0		SEE Marks	50
Total Hours of Pedagogy	3 hours per week		Total Marks	100
Credits	1		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- 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 and Introduce the concepts of exception handling and multithreading.
- To Understand and Introduce the design of a Graphical User Interface using applets and swing controls.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that 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 method, You Tube Videos, Power Point Presentation.
RBT Levels	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 method, You Tube Videos, Power Point Presentation.
RBT Levels	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 method, You Tube Videos, Power Point Presentation.
RBT Levels	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 method, You Tube Videos, Power Point Presentation.
RBT Levels	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 method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2,L3

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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

The Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

5. The question paper will have ten questions. Each question is set for 10 marks.
6. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
7. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text 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
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Programming skills to solve real world problems. • Quizzes • Assignments • Micro project to enrich skill/knowledge in the subject

Network Security			Semester	VI
Course Code	AEC	**BEI657C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0		SEE Marks	50
Total Hours of Pedagogy	40 hours		Total Marks	100
Credits	1		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Describe network security services and mechanisms.
- Understand Transport Level Security and Secure Socket Layer
- Know about Security concerns in Internet Protocol security
- Discuss about Intruders, Intrusion detection and Malicious Software
- Discuss about Firewalls, Firewall characteristics, Biasing and Configuration

Teaching-Learning Process (General Instructions)
These are sample Strategies; that 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.
- 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

Attacks on Computers and Computer Security: Need for Security, Security Approaches, Principles of Security Types of Attacks.
(Chapter 1 -Text 2)

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2

MODULE-2

Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH)
(Chapter 15 - Text 1)

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2

MODULE-3	
IP Security: Overview of IP Security (IPSec),IP Security Architecture, Modes of Operation, Security Associations (SA), Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange. (Chapter 19 – Text 1)	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2
MODULE-4	
Intruders, Intrusion Detection.(Chapter20-Text1) **Malicious Software:** Viruses and Related Threats, Virus Counter measures, (Chapter21-Text1)	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE-5	
Firewalls: The Need for firewalls, Firewall Characteristics, Types of Firewalls, Firewall Biasing, Firewall location and configuration (Chapter 22 - Text 1)	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3

Course outcomes (Course Skill Set):

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

1) Explain network security services and mechanisms and explain security concepts
2) Understand the concept of Transport Level Security and Secure Socket Layer.
3) Explain Security concerns in Internet Protocol security
4) Explain Intruders, Intrusion detection and Malicious Software
5) Describe Firewalls, Firewall Characteristics, Biasing and Configuration

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1) Cryptography and Network Security Principles and Practice , Pearson Education Inc., William Stallings, 5th Edition, 2014, ISBN: 978-81-317- 6166-3.
2) Cryptography and Network Security, Atul Kahate, TMH, 2003.

Reference Books

1) Cryptography and Network Security, Behrouz A. Forouzan, TMH, 2007.

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

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

Machine Learning with Python			Semester	VI
Course Code	AEC	**BEI657D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:1:0:0		SEE Marks	50
Total Hours of Pedagogy	3 hours per week		Total Marks	100
Credits	1		Exam Hours	3
Examination nature (SEE)	Theory			

Course objectives:
After completion of the course, the students will be able to

- Define machine learning and problems relevant to machine learning.
- Differentiate supervised, unsupervised and reinforcement learning
- Apply neural networks, Bayes classifier and k nearest neighbour, for problems appear in machine learning.
- Perform statistical analysis of machine learning techniques.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that 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.
- 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: Well posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning.
Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.
Python libraries suitable for Machine Learning: Numerical Analysis and Data Exploration with NumPy Arrays, and Data Visualization with Matplotlib
Text Book 1, Sections: 1.1 — 1.3, 2.1-2.5, 2.7

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation.
RBT Levels	L1, L2, L3, L4

MODULE-2

Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning. Example program in Python Text Book 1, Sections: 3.1-3.7	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE-3	
Artificial Neural Networks : Introduction, Neural Network representation, Appropriate problems, Perceptrons, Back propagation algorithm. Example program in Python Text book 1, Sections: 4.1 — 4.6	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
MODULE-4	
Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm, Example program in Python. Text book 1, Sections: 6.1— 6.6, 6.9, 6.11, 6.12	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3, L4
MODULE-5	
Evaluating Hypothesis: Motivation, Estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms. Instance Based Learning: Introduction, k-nearest neighbor learning, locally weighted regression, radial basis function, cased-based reasoning, Reinforcement Learning: Introduction, Learning Task, Q Learning Example program in Python. Text book 1, Sections: 5.1-5.6, 8.1-8.5, 13.1-13.3	
Teaching-Learning Process **RBT Levels**	Chalk and talk method, You Tube Videos, Power Point Presentation. L1, L2, L3
Course outcomes (Course Skill Set): At the end of the course, the student will be able to: 1) Identify the problems in machine learning. 2) Select supervised, unsupervised or reinforcement learning for problem solving. 3) Apply theory of probability and statistics in machine learning 4) Apply concept learning, ANN, Bayes classifier, K nearest neighbour 5) Perform statistical analysis of machine learning 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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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.	

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

Suggested Learning Resources:

Text Books

1) Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.

Reference Books

2) Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, 2nd edition, springer series in statistics.
3) Ethem Alpay4n, Introduction to machine learning, second edition, MIT Press.

Web links and Video Lectures (e-Resources):

- https://www.analyticsvidhya.com/blog/2015/04/comprehensive-guide-data-exploration-sas-using-python-numpy-scipy-matplotlib-pandas/
- https://www.oreilly.com/library/view/python-for-data/9781491957653/chOl.html

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

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- Quizzes
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- Seminar