Analysis and Design of Digital Circuits (Theory and Practice)		Semester	III
Course Code	**22EA302**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 +2 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40 L+ 26 P	Total Marks	100
Credits	03 + 02	Exam Hours	3+3 Hrs
Examination type (SEE)	Theory + Practical		

Course objectives:

- Familiarize with the simplification techniques & design various combinational digital circuits using logic gates.
- Introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
- Analysing & designing different applications of Combinational & Sequential Circuits
- Analysing & designing sequential circuits using SR, JK, D, T flip-flops and Mealy & Moore machines
- Know the importance of programmable devices used for designing digital circuits.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *Number systems, Boolean Algebra, Logic Gates, Comparison of Combinational & Sequential Circuits.*

Principles of combinational logic: Introduction, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 variables, Incompletely specified functions (Don‘t care terms), Quine-McClusky techniques- 3 & 4 variables.

Module-2

Prerequisites**:** *Decoder, Encoders, Multiplexers & Demultiplexer*

Design and Analysis of combinational logic: Full Adder & Subtractors, Parallel Adder and Subtractor, Look ahead carry Adder, Binary comparators, Decoders & Multiplexers as minterm/maxterm Generator.

Module-3

Prerequisites**:** *SR, JK, D, T flipflops*

Flip-Flops and its Applications: Latches and Flip Flops, Master-slave JK flip-flop, Timing concerns in sequential circuits, Shift Registers – SISO, SIPO, PISO PIPO, Universal shift register, Counters – Synchronous and Asynchronous.

Module-4

Sequential Circuit Design: Characteristic equations, Design of a synchronous mod-n counter using clocked JK, D, T and SR flip-flops, Melay& Moore Models

Module-5

Applications of Digital Circuits:

Design of a Sequence Detector, Guidelines for construction of state graphs, Design Example – Code Converter, Design of Binary Multiplier, Design of Binary Divider.

Programmable Logic Devices: PLA, PAL, FPGA.

LABORATORY EXPERIMENTS

1. Verify
   a) The sum-of product expression using universal gates.
   b) The product-of-sum expression using universal gates.
2. Design and implement
   (a) Full Adder using basic logic gates.
   (b) Full subtractor using basic logic gates.
3. Design and implement
   4-bitParallelAdder/ Subtractor using IC 7483.
4. Design and implement BCD to Excess-3 code conversion and vice-versa using IC 7483.
5. Realize
   (i) Adder & Subtractors using IC 74153
6. Realize 4-variable function using IC 74151(8:1MUX)
7. Realize the following flip-flops using NAND Gates.
   (a) Clocked SR Flip-Flop
   (b) JK Flip-Flop
8. Design and implement the following flip-flops using NAND Gates
   (a) D-Flip-Flop
   (b) T-Flip-Flop
9. Realize the following shift registers using IC7474
   (a)SISO (b) SIPO (c) PISO (d) PIPO
10 Realize the following shift registers using IC7474

(a) Ring Counter (b) Johnson Counter.

11. Realize

(a) Mod-N Counter using IC7490

Virtual Lab Links: http://vlabs.iitkgp.ernet.in/dec/

Course outcome (Course Skill Set)

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

1. Illustrate simplification of Algebraic equations using K-map & Quine-McCluskey Technique.
2. Design the combinational logic circuits.
3. Analyse& design different applications of Combinational & Sequential Circuits to meet desired need within realistic constraints.
4. Design the sequential circuits using SR, JK, D, T flip-flops and Mealy & Moore machines
5. Know the importance of programmable devices used for designing digital circuits.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning,
2. 2001.
3. Donald D. Givone, "Digital Principles and Design", McGraw Hill, 2002.
4. Charles H Roth Jr., Larry L. Kinney —Fundamentals of Logic Design, CengageLearning, 7th Edition.
5. . Morris Mano, —Digital Design‖, Prentice Hall of India, Third Edition.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117108040/

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**2**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Analog Electronic Circuits (Theory and Lab)		Semester	III
Course Code	**22EA303**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3+2 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L+26 P	Total Marks	100
Credits	03+02	Exam Hours	3+3 Hrs
Examination type (SEE)	Theory+ Practical		

Course objectives:

- To know low frequency response for various configurations of BJT and FET amplifier.
- Understand the different topologies of feedback amplifiers and oscillators.
- Analyse the Power amplifier circuits in different modes of operation
- Sketch and explain typical Frequency Response graphs for each of the Filter circuits and switching circuits of Op-Amps and analyse its operations.
- Differentiate between various types of DACs and ADCs, Timer IC's and evaluate the performance of each with neat circuit diagrams.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *Operation of Transistor*

Transistor Biasing:

Fixed bias circuits, Emitter stabilized biased circuits, Voltage divider biased circuits.

Transistor at Low Frequencies: BJT transistor modeling, CE Fixed bias configuration, Voltage divider bias, Emitter follower, Analysis of circuits re model.

Module-2

Prerequisites: *Working of JFET*

FET Amplifiers: JFET small signal model, Fixed bias configuration, Voltage divider configuration, Common Gate configuration,

Feedback Amplifier: The Four Basic Feedback Topologies, The series-shunt, series-series, shunt-shunt and shunt-series amplifiers.

Module-3

Oscillators: Oscillator operation, FET based Phase shift oscillator, Wien bridge oscillator, LC and Crystal Oscillators.

Output Stages and Power Amplifiers: Introduction, Classification of output stages, Class A output stage, Class B output stage: Transfer Characteristics, Power Dissipation, Power Conversion efficiency, Class AB output stage, Class C tuned Amplifier.

Module-4

OP-Amps as DC Amplifiers: Direct coupled voltage followers, Non-inverting amplifiers, inverting amplifiers.

Op-Amps as AC Amplifiers: Capacitor coupled voltage follower, Capacitor coupled non inverting amplifiers, Capacitor coupled inverting amplifiers, Capacitor coupled difference amplifier.

Module-5

Op-Amp Circuits: DAC - Weighted resistor and R-2R ladder, ADC- Successive approximation type, Active Filters, First and second order low-pass and high-pass Butterworth filters, Band-pass filters, Band reject filters.

555 Timer and its applications: Mono-stable and Astable Multivibrators.

Laboratory Experiments

1. Design and set up the RC coupled Single stage BJT amplifier and determine the gain-frequency response, input and output impedances

2.Design an oscillator with tank circuit having two inductances and one capacitance and compare the practical frequency with theoretical frequency.

3.Design an oscillator with tank circuit having two capacitance and one inductance and compare the practical frequency with theoretical frequency.

4. Design an Oscillator using FET whose tank circuit produces a total phase shit of 180 and calculate the frequency of output waveform.

5. Design an oscillator whose frequency is 2MHZ and compare with the theoretical frequency.

6. Find a suitable power amplifier that removes the cross over distortion and calculate the efficiency

7. Design active second order Butterworth low pass filters.

8. Test a comparator circuit and design a Schmitt trigger for the given UTP and LTP

values and obtain the hysteresis.

9.Design 4 bit R – 2R Op-Amp Digital to Analog Converter (i) using 4 bit binary input

from toggle switches and (ii) by generating digital inputs using mod-16 counter.

10. Design Astable Multivibrator using 555 Timer.

11. Design Monostable Multivibrator using 555 Timer.

12. To set up and study a triangular waveform generator using Op-amp for 1kHz frequency .

Course outcome (Course Skill Set)

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

1. Analyse the DC biasing & frequency response of BJT Amplifier and FET amplifier
2. Design various Feedback amplifiers.
3. Evaluate the efficiency of power amplifiers and working of oscillator.
4. Describe DC amplifier, AC Amplifiers and its application.
5. Acquire knowledge about Active Filters, DAC, ADC and Timer.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Robert L.Boylestad and louis Nashelsky, "Electronic Devices and circuit Theory", PHI/Pearson Education,11 TH Edition.
2. Adel S Sedra, Kenneth C Smith "Microelectronic Circuits, Theory and Applications", 6th Edition, Oxford, 2015.ISBN:978-0-19-808913-1.
3. Behzad Razavi, "Fundamentals of Microelectronics", John Weily ISBN 2013 978-81- 265-2207-8,2nd Edition, 2013.
4. K.A.Navas, "Electronics Lab Manual", Volume I, PHI, 5th Edition, 2015, ISBN: 9788120351424.
5. "Operational Amplifiers and Linear IC‟s", David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2259-9.

6. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

Web links and Video Lectures (e-Resources):

- http://www.nptelvideos.in/2012/12/electronics.html

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

NETWORK ANALYSIS		Semester	III
Course Code	**22EA304**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 2:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Describe basic network concepts emphasizing source transformation source shifting, mesh and nodal techniques to solve for resistance/impedance, voltage, current and power.
- Explain network Thevenin's, Millman's, Superposition, Reciprocity, Maximum Power transfer and Norton's Theorems and apply them in solving the problems related to Electrical Circuits.
- Describe Series and Parallel Combination of Passive Components as resonating circuits, related parameters and to analyze frequency response.
- Explain the behavior of networks subjected to transient conditions. Use applications of Laplace transform to solve network problems.
- Study two port network parameters like Z, Y, T and h and their inter-relationships.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *Ohm's law, Kirchhoff's laws*

Basic Concepts: Introduction, Practical sources, Source transformations, Star – Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC networks, Concepts of super node and super mesh.

Module-2

Graph Theory and Network equations: Graph of a network, Trees, Co-trees and Loops, Incidence Matrix, Cut-set Matrix, Tie-set Matrix and loop currents, Number of possible trees of a graph, Analysis of networks, Duality.

Module-3

Network Theorems: Superposition Theorem, Millman's theorem, Thevenin's and Norton's theorems, Reciprocity theorem, Maximum Power transfer theorem.

Module-4

Prerequisites: *Laplace Transforms, Properties of Laplace Transform and Inverse Laplace Transform using partial fraction method.*

Transient behaviour and initial conditions: Behaviour of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations, Applications of Laplace Transforms in circuit analysis.

Module-5

Two port network parameters: Introduction, open circuit impedance parameter, short circuit admittance parameter, hybrid parameters, transmission parameter, relationship between parameters.

Course outcome (Course Skill Set)

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

1. Determine currents and voltages in a circuit using network simplification techniques.
2. To solve the network problems using graphical methods.
3. To simplify the complex circuits using network theorems.
4. To analyze simple DC circuits and applies the concepts to transient conditions.
5. Solve the given network using specified two port network parameters like Z or Y or T or h and Evaluate frequency response related parameters through the RLC elements, in resonant circuits.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. M.E. Van Valkenberg (2000), "Network analysis", Prentice Hall of India, 3rd edition, 2000, ISBN: 9780136110958.
2. Roy Choudhury, "Networks and systems", 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677.
3. Hayt, Kemmerly and Durbin —Engineering Circuit Analysis", TMH 7th Edition, 2010.
4. J. David Irwin /R. Mark Nelms, "Basic Engineering Circuit Analysis", John Wiley, 8th edition, 2006.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=UMhBgyK8F0U
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Analog and Digital Electronics Laboratory		Semester	III
Course Code	**22EAL305**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2 Hours/Week (L:T:P: 0:0:2)	SEE Marks	50
Total Hours of Pedagogy	20	Total Marks	100
Credits	02	Exam Hours	3 Hrs
Examination type (SEE)	Practical		

Course objectives:

- Demonstrate various circuits using PSPICE and verify functionality.
- To be exposed to the operation and application of electronic devices and their circuits.
- To analyze circuit characteristics with signal analysis using Op-amp ICs.
- Familiarize with Modern EDA tool such as Verilog.
- Acquire knowledge on different types of description in Verilog.

Teaching-Learning Process (General Instructions)

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

PART A

Simulation using EDA software (EDWinXP, PSpice, MultiSim, Proteus, CircuitLab or any other equivalent tool can be used)

1. Monostable Multivibrator using 555 Timer.
2. Astable Multivibrator using 555 Timer.
3. RC Phase shift oscillator.
4. Inverting Schmitt Trigger.
5. Narrow Band-pass Filter and Narrow band-reject filter

Precision full-wave rectifier.
PART B
Simulate the following using Verilog Code 1. Write a Verilog program for 2 to 4 decoder. 2. Write a Verilog program for 8 to 3 encoder (without priority & with priority) 3. Write Verilog code to convert 4 bit binary to gray code. 4. Write a Verilog code for 8 to 1 multiplexer 5.Write Verilog code of Comparator
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Demonstrate various circuits using PSPICE and verify functionality. 2. Design and test of analog circuits using OPAMPs 3. Design and implement basic circuits using IC (OPAMP and 555 timers). 4. Use the modern engineering tool such as Verilog necessary for engineering practice. 5. Write code and verify functionality of digital circuit/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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

Web links and Video Lectures (e-Resources):

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**1**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**1**	**2**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**1**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Engineering Science Course:

Digital System Design using Verilog		Semester	III
Course Code	**22EA306A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the concepts of Verilog Language
- Study of verilog data flow descriptions.
- Study of design and operation of behavioral programming using verilog
- Understand the concepts of Verilog Structural Language
- Design and diagnosis of verilog circuits using synthesis module.

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

Module-1

Introduction to Verilog: Structure of verilog Module, Operators, Data types, Units and ports, Verilog constructs.

Module-2

Data-Flow Description: Highlights Of Data-Flow Description, Signal Declaration And Assignment Statement , Constant Declaration and Constant Assignment Statements , Assigning a Delay Time to the Signal-Assignment Statement .

Module-3

Behavioral Description: Behavioral Description Highlights, Structure of the Verilog Behavioral Description , Sequential Statements: IF Statement , The case Statement , Verilog casex and casez , The wait-for Statement , The Loop Statement: For-Loop, While-Loop , Verilog repeat , Verilog forever

Module-4

Structural Description: Highlights of Structural Description, Organization of Structural Description , Half adder and full adder design using structural description, Half subtractor and full subtractor design using structural description, generate and parameter (Verilog) , Exercises

Module-5

Synthesis Basics: Highlights of Synthesis, Synthesis Information From Module , Mapping Always in the Hardware Domain ,Mapping the Signal-Assignment Statement to Gate Level, Mapping Logical Operators, Mapping the IF Statement, Mapping the case Statement , Mapping the Loop Statement

Course outcome (Course Skill Set)

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

1. Understand verilog programming basics
2. Describe how dataflow description of verilog code works and write simple programs using dataflow description.
3. Describe how Behavioural description of verilog code works and write simple programs using dataflow description.
4. Design simple circuits using verilog structural description.
5. Synthesize different assign statements and simple applications using verilog.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. HDL WITH DIGITAL DESIGN VHDL AND VERILOG, Nazeih Botros, MERCURY LEARNING AND INFORMATION Dulles, Virginia Boston, Massachusetts New Delhi, 2015.
2. Samir Palnitkar "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition
3. Charles H Roth Jr., Larry L. Kinney "Fundamentals of Logic Design", Cengage Learning, 7th Edition

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=FT03XrQ8Bi4
-

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

SENSOR AND INSTRUMENTATION (Theory)		Semester	III
Course Code	**22EA306B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- To understand the basic concepts of transducers.
- To identify the mathematical model of transducer and its response for various inputs.
- To understand the construction and working principle of resistive type transducers.
- To impart knowledge on capacitive type and inductive type transducer.
- To understand the construction and working principle of sensors and its real time applications.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *knowledge of basic of sensors*

General block diagram of measurements systems – Methods of measurements – Classification and selection of transducers – Error analysis – Statistical methods – Odds and uncertainty, classification of instruments, applications of measurement systems.

Module-2

Static characteristics – Accuracy, precision, resolution, sensitivity, linearity – Dynamic characteristics – Mathematical model of transducer – Zero, first and second order transducers – Response for impulse, step, ramp and sinusoidal inputs

Module-3

Principle of operation – Construction details – Characteristics and application of resistance potentiometer – Strain gauge – Resistance thermometer – Thermistor – Hot-wire anemometer – Humidity sensor – Induction potentiometer – Variable reluctance transducers – LVDT.
Module-4
Capacitive transducer and types – Capacitor microphone – Frequency response – Piezoelectric transducer – Hall effect transducer – Magnetostrictive – Digital transducers – Fiber optic sensors – Thick and thin film sensors (Bio sensor and chemical sensor).
Module-5
Environmental monitoring sensors (Water quality and air pollution) – Photo electric transducer – Vibration sensor – Ultrasonic based sensors – Introduction to MEMS and Nanotechnology – Applications – Robotics – Home appliance.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Choose appropriate sensors for the measurement of various physical parameters. 2. Obtain the mathematical model of the transducer and its response for various inputs. 3. Choose appropriate resistive type transducer for the measurement of various physical parameters. 4. Select capacitive and inductive type transducers for the measurement of various physical parameters. 5. Select the suitable type of sensors for real time applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. "A Course in Electrical and Electronics Measurements and Instrumentation", Sawhney A K, Dhanpat Rai and Sons, New Delhi, 2013
2. "Sensors and Transducers", Patranabis D, Prentice Hall of India, Second Edition, 2010
3. "Transducers and Instrumentation", Murthy D V S, Prentice Hall of India, New Delhi,
4. Second Edition, 2010.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=78NpGnA1sX4
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

COMPUTER ORGANIZATION & ARCHITECTURE (Theory)		Semester	III
Course Code	**22EA306C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Explain the basic sub systems of a computer, their organization, structure and Operation.
- Illustrate the concept of programs as sequences of machine instructions.
- To understand the different ways of communicating with I/O devices and to introduce memory types including cache memories.
- Describe memory hierarchy and concept of virtual memory.
- To analyse concepts of Pipelining and other computing systems.

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

Module-1

Basic Structure of Computers: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance – Processor Clock, Basic Performance Equation.

Machine Instructions and Programs: Numbers, Arithmetic Operations and Characters, IEEE standard for Floating point Numbers, Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing.

Module-2

Prerequisite :*Number system*

Addressing Modes: Assembly Language, Basic Input and Output Operations, Stacks and Queues, Subroutines, Additional Instructions.

Module-3
Input/Output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Direct Memory Access, and Buses.
Module-4
Memory System: Basic Concepts, Semiconductor RAM Memories-Internal organization of memory chips, Static memories, Asynchronous DRAMS, Read Only Memories, Cash Memories, Mapping Functions, Replacement Algorithm, Virtual Memories, Secondary Storage-Magnetic Hard Disks.
Module-5
Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control, Micro programmed Control ,Pipelining ,Basic concepts, Role of Cache memory, Pipeline Performance
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Identify the functional units of the processor and the factors affecting the performance of a computer 2. Demonstrate the ability to classify the addressing modes, instructions sets and design programs. 3. Understand the different ways of accessing an input / output device including interrupts. 4. Illustrate the organization of different types of semiconductor and other secondary storage memories. 5. Illustrate the simple processor organization based on hardwired control and micro programmed control.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Carl Hamacher, ZvonkoVranesic, SafwatZaky: "Computer Organization", 6th Edition, Tata McGraw Hill, 2011.
2. Andrew S. Tanenbaum, Todd Austin, "Structured Computer Organization", 6th Edition, Pearson, 2013.
3. David A. Patterson, John L. Hennessy: "Computer Organization and Design – The Hardware / Software Interface ARM Edition", 4th Edition, Elsevier, 2009.
4. William Stallings: "Computer Organization & Architecture", 7th Edition, PHI, 2006.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=K7fnDf-P6_c#action=share
-

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Engineering Electromagnetics		Semester	IV
Course Code	**22EA401**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2 Hours/Week (L:T:P: 2:0:0)	SEE Marks	50
Total Hours of Pedagogy	30L	Total Marks	100
Credits	02	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the applications of Coulomb's law and Gauss law to different charge Distributions.
- Understand the physical significance of Biot-Savart's Law, Amperes' Circuital Law and Stokes' theorem for different current distributions.
- Know the physical interpretation of Maxwell's equations and its applications in plane waves.
- Understand the concepts of Smith Chart for impedance matching.
- Acquire knowledge on different types of transmission lines.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *Vector Algebra, Coordinate systems (Rectangular Coordinate System, Cylindrical Coordinate System and Spherical Coordinate System), gradient, divergence and curl*

Electrostatics: Coulomb's Law, Electric Field Intensity, Flux density and potential:

Coulomb's law , Electric field intensity, Field due to line charge, Field due to Sheet of charge, Field due to continuous volume charge distribution, Electric flux, Electric flux density, Electric potential, Potential difference, relation between Electric field intensity (E) & potential (V), potential gradient, Electric dipole, Energy density in electrostatic fields.

Module-2

Gauss' law, Divergence, Poisson's and Laplace's Equations:

Gauss law, Maxwell's First equation, Application of Gauss' law, Divergence theorem, Current, Current density, Conductor, The continuity equation, Boundary conditions (dielectric-dielectric, conductor-dielectric, conductor-free space), Poisson's and Laplace's Equations, Uniqueness theorem.

Module-3

Magnetostatics: Steady Magnetic Field-Biot-Savart Law, Ampere's circuital law, Curl, Stokes' theorem, Gauss's law for magnetic fields, Magnetic flux and Magnetic flux density, Maxwell's equations for static fields, Magnetic Scalar and Vector Potentials.

Magnetic Forces and magnetic materials: Force on a moving charge and differential current element, Force between differential current elements, Magnetization, magnetic susceptibility, permeability, Magnetic boundary conditions, Inductances, magnetic energy, magnetic circuit.

Module-4

Time varying Fields and Electromagnetic wave propagation: Time varying fields & Maxwell's equations, Faraday's law, Transformer and Motional Electro - Motive Forces, Displacement current, Maxwell's equation in differential and integral form, Time varying potentials.

Electromagnetic wave propagation: Derivation of wave equations from Maxwell's equations, Relation between E and H, Wave propagation in - lossy dielectrics, lossless dielectrics, free space and good conductor, skin-effect, Poynting theorem.

Module-5

Transmission line: Introduction, Transmission line parameters, Transmission line equations, input impedance, standing wave ratio and power, Smith Chart basic fundamentals, types of transmission lines - coaxial line, strip line, micro strip line.

Applications of transmission line: Impedance matching and tuning: single stub tuning, double stub tuning, and the quarter wave transformer.

Laboratory Sessions/ Experimental learning: Simulation of micro strip transmission line using FEKO software.

Course outcome (Course Skill Set)

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

1. Evaluate problems on electrostatic force, electric field due to point, linear, surface charge and volume charges.
2. Apply Gauss law to evaluate Electric fields due to different charge distributions by using Divergence Theorem. Determine potential and capacitance using Laplace equation and Poisson equation.
3. Apply Biot-Savart's and Ampere's laws for evaluating Magnetic field for different current configurations.
4. Apply Maxwell's equations for time varying fields and evaluate power associated with EM waves using Poynting theorem.
5. Determine the parameters of transmission lines and use Smith chart for determining the impedance and admittance.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
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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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, Edition VII, 2018.
2. David M Pozar, "Microwave Engineering", John Wiley & Sons, Inc., 4th edition, 2014.
3. W.H. Hayt. J.A. Buck & M Jaleel Akhtar, "Engineering Electromagnetics", Tata McGraw – Hill, Edition VIII, 2014.

Web links and Video Lectures (e-Resources):

- https://youtu.be/ckAVB3_NP2Q
- https://youtu.be/IH2fFNaR9YM
- https://youtu.be/JhTT-wew-OE

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	-	-	-	1
CO2	3	3	3	2	2	1	-	-	-	-	-	1
CO3	3	3	3	2	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	3	3	3	2	2	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Principles of Communication Systems (Theory and Lab)		Semester	IV
Course Code	**22EA402**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3+2 Hours/Week (L:T:P: 3:0:2)	SEE Marks	50
Total Hours of Pedagogy	40L+26P	Total Marks	100
Credits	03+02	Exam Hours	3+3 Hrs
Examination type (SEE)	Theory+ Practical		

Course objectives:

- Understand the concepts of Analog Modulation schemes viz; AM, FM.
- Interpret the different types of noise in communication system.
- Learn the concepts of digitization of signals viz; sampling, quantizing, and encoding.
- Analyze the Base Band data transmission system.
- Realize the basic concepts of coherent and non-coherent digital modulation techniques and
- understand the basics of spread spectrum modulation.

Teaching-Learning Process (General Instructions)

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

Module-1

Prerequisites: *Modulation, Need for Modulation, and types of Modulation.*

Amplitude Modulation: Introduction to AM, Time-Domain description, Frequency- Domain description, Generation of AM wave: Square Law Modulator, Switching modulator,Detection of AM waves: Envelop detector.

Double side band suppressed carrier modulation (DSBSC): Time-Domain description, Frequency-Domain representation, Generation of DSBSC waves: Ring modulator. Coherentdetection of DSBSC modulated waves. Costas loop.

Single Side-Band Modulation (SSB): Single side-band modulation, Time-Domain description, Frequency-Domain description of SSB wave, Phase discrimination method for generating an SSB modulated wave.

Module-2

Frequency Modulation: Basic definitions, FM, narrow band FM, wide band FM, transmission bandwidth of FM waves, and generation of FM waves: indirect FM and direct FM.

Demodulation of FM waves: Phase-locked loop, Nonlinear model of the phase – lockedloop, Linear model of the phase – locked loop, Nonlinear effects in FM systems.

Noise: Introduction, Types of noise, Noise Figure, Equivalent noise temperature, Noise inAM receivers, Noise in FM receivers, Superheterodyne receivers.

Module-3

NOISE: Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth.

NOISE IN ANALOG MODULATION: Introduction, Receiver Model, Noise in DSB-SCreceivers. Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect,FM threshold effect, FM threshold reduction, Pre-emphasis, and De-emphasis in FM

Module-4

Inter-symbol Interference & Signal Space representation: Base band transmission: Discrete PAM Signals, Power spectra of Discrete PAM Signals, Inter Symbol Interference, Nyquist criterion for Distortion less Base band Binary Transmission, Eye diagram, Geometric representation of signals, Gram-Schmidt Orthogonalization procedure, Optimum receivers for coherent detection: Correlation Receivers and Matched Filter receiver.

Module-5

Prerequisites: *Probability & Random Process*

Pass band transmission: Digital modulation techniques: Phase shift Keying techniques using Coherent detection: Generation, Detection and Error probabilities of BPSK and QPSK,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 of Transmitter and Receiver, Probability of error (without derivation of probability of error equation)

Principles of Spread Spectrum Communication Systems: Model of a Spread Spectrum, Digital Communication System, Direct Sequence Spread Spectrum Systems (DSSS),Some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum (FHSS).

Lab Experiments

Hardware Experiments

1. Amplitude Modulation and Demodulation using transistor
2. DSB SC Modulation.
3. Frequency modulation and FSK using IC 8038/2206
4. Pre-emphasis & de-emphasis

5. Demonstrate sampling and reconstruction Pulse Amplitude Modulation and Detection
6. Generation of PWM/PPM signal
7. Generation and detection of ASK Waveform
8. FSK Generation and detection.
9. TDM of two band limited signals.

Course outcome (Course Skill Set)

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

1. Examine the concepts of analog modulation techniques such as amplitude, modulations and its variations like DSB-SC and SSB-SC.
2. Analyze frequency modulation and compute performance of different types of noise.
3. Apply the concepts of noise in analog modulation and analysis of pre-emphasis and
4. deemphasis circuit.
5. Analyze the signal space representation of digital signals.
6. Evaluate the performance of a baseband and pass band digital communication system.
7. and spread spectrum 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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
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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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Simon Haykins& Moher, Communication Systems, 5th Edition, John Wiley, India Pvt. Ltd,
2. 2010, ISBN 978 – 81 – 265 – 2151 – 7.
3. Simon Haykins, "An Introduction to Analog and Digital Communication", John Wiley, 2003.
4. John G Proakis and MasoudSalehi, "Fundamentals of Communication Systems", 2014
5. Edition, Pearson Education, ISBN 978-8-131-70573-5.
6. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford
7. University Press., 4th edition, 2010, ISBN: 97801980738002.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117/105/117105143/
- https://youtu.be/00ZbuhPruJw

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Modern Control systems		Semester	IV
Course Code	**22EA403**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	4 Hours/Week (L:T:P: 4:0:0)	SEE Marks	50
Total Hours of Pedagogy	50L	Total Marks	100
Credits	04	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Formulate the mathematical modelling of systems and understand the concepts of transfer function
- Obtain transfer function using block diagram reduction and signal flow graph techniques.
- Analyse the response of first and second order systems using standard test signals and analyse steady state error.
- Analyse stability of systems using RH criteria, Root Locus, Nyquist, Bode plot and polar plot.
- Obtain state variable model for electrical systems.

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

Module-1

Introduction to Control Systems: open loop and closed loop systems, Types of feedback, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems.

Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.

Module-2

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems for underdamped system, steady state errors and error constants.

Module-3

Stability analysis using RH Criteria and root locus: Concepts of stability, Necessary conditions for stability, Routh Hurwitz stability criterion, Relative stability analysis, Introduction to Root-Locus Techniques, the root locus concepts, Construction of root loci.

Module-4

Stability analysis using Nyquist criteria and Bode plots: Polar plot, Nyquist Stability criterion, Nyquist plots, Bode plots, Gain and phase margin.

Module-5

Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Solution of state equations, State transition matrix and its properties.Lag, lead and lag lead compensation.

Course outcome (Course Skill Set)

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

1. Write the mathematical model for electrical systems and find the transfer function using block diagram reduction technique and signal flow graph.
2. Analyze transient and steady state response of second order systems using standard test signals and analyze steady state error.
3. Analyze the stability of the systems by applying RH criteria and root locus techniques.
4. Analyze the stability of the system using frequency domain techniques such as Nyquist and Bode plots.
5. Write state space equations and solutions of a given electrical 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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Nagarath and M.Gopal, — Control Systems Engineering‖, New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-
2. Modern Control Engineering, K.Ogata, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
3. Automatic Control Systems‖, Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.

Web links and Video Lectures (e-Resources):

- https://youtu.be/R0E3uKSKdME
- https://youtu.be/zXMklO-jxIo
-

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**	**-**	-	-	-	-	-	-	-
CO2	**3**	**2**	**2**	**1**	**-**	-	-	-	-	-	-	-
CO3	**3**	**2**	**2**	**2**	**-**	-	-	-	-	-	-	-
CO4	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-
CO5	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Communication laboratory		Semester	IV
Course Code	**22EAL404**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2 Hours/Week (L:T:P: 0:0:2)	SEE Marks	50
Total Hours of Pedagogy	26P	Total Marks	100
Credits	02	Exam Hours	3 Hrs
Examination type (SEE)	Practical		

Course objectives:

- To visualize the effects of sampling and TDM
- To Implement AM & FM modulation and demodulation
- To implement PCM & DM
- To simulate Digital Modulation schemes

Teaching-Learning Process (General Instructions)

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

EXPERIMENTS

1. Signal Sampling and reconstruction
2. Time Division Multiplexing
3. AM Modulator and Demodulator
4. FM Modulator and Demodulator
5. Pulse Code Modulation and Demodulation
6. Delta Modulation and Demodulation
7. Line coding schemes
8. Simulation of ASK, FSK, and BPSK generation schemes

9. Simulation of DPSK, QPSK and QAM generation schemes
10. Simulation of signal constellations of BPSK, QPSK and QAM
11. Simulation of ASK, FSK and BPSK detection schemes
12. Simulation of Linear Block and Cyclic error control coding schemes
13. Simulation of Convolutional coding scheme
14. Communication link simulation

Course outcome (Course Skill Set)

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

1. Simulate & validate the various functional modules of a communication system.
2. Demonstrate their knowledge in base band signaling schemes through
3. Implementation of digital modulation schemes.
4. Apply various channel coding schemes & demonstrate their capabilities.
5. Towards the improvement of the noise performance of communication 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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

Web links and Video Lectures (e-Resources):

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

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	-	-	-	1
CO2	3	3	3	2	1	1	-	-	-	-	-	1
CO3	3	3	3	2	1	1	-	-	-	-	-	1
CO4	3	3	3	2	1	1	-	-	-	-	-	1
CO5	3	3	3	2	1	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

8051 Microcontroller		Semester	IV
Course Code	**22EA405A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller.
- Write 8051 Assembly level programs using 8051 instruction set
- Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.
- Interfacing of 8051 to external memory.
- Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

Teaching-Learning Process (General Instructions)

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

Module-1

8051 Microcontroller:

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

Module-2
8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.
Module-3
8051 Stack, I/O Port Interfacing and Programming:8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.
Module-4
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.
Module-5
8051 Interrupts and Interfacing Applications: 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051. 2. Write 8051 Assembly level programs using 8051 instruction set. 3. Write 8051 Assembly language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port and to generate an external interrupt using a switch. 4. Write 8051 Assembly language programs to generate square wave on 8051 I/O port pin using interrupt and C Program to send & receive serial data using 8051 serial port. 5. Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
2. "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.
3. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.
4. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=QGg5jZEdT7A&list=PLgwJf8NK-2e49i6neo70aGtFLvKeZ3IQD
- https://www.youtube.com/watch?v=2-geyR_aM28&pp=ygUVODA1MSBtaWNyb2NvbnRyb2xsZXIg

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

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	-	-	1	1
CO2	3	3	2	3	3	-	-	-	-	-	3	2
CO3	3	3	2	3	3	-	-	-	-	-	3	1
CO4	3	3	2	2	3	-	-	-	-	-	3	1
CO5	3	2	2	3	3	-	-	-	-	-	3	2

High-3, Medium-2, Low-1

Data Structures and Algorithms using Python		Semester	IV
Course Code	**22EA405B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the fundamentals of data structures and their applications in logic building and project assessment.
- Understand the concept of linked lists and sorting techniques.
- Acquire the knowledge of algorithms of queues and stacks.
- Analyze the concepts of Binary trees.
- To Understand Graphs and its algorithms.

Teaching-Learning Process (General Instructions)

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

Module-1

Python Primer: Python Overview, Objects in Python, Expressions, Operators, Control Flow, Functions, Simple i/p and o/p, Modules.

Basic Concepts of Data Structures and Algorithms: Introduction- Variables, Datatypes, Data Structures, ADT, what is an algorithm, How to compare algorithms, Rate growth, Types of analysis, Asymptotic Notation, Performance Analysis: Space complexity, Time complexity, Guidelines for asymptotic analysis.

Module-2

Prerequisites: Programming using the concept of Arrays and pointers

Linked Lists: Definition, Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists and its operations, Circular linked lists and its operations.

Sorting Techniques: Bubble Sort, Insertion Sort, Selection Sort, Quick Sort and Merge Sort.

Module-3

Stacks: Definition, Stack Implementation using arrays/lists and linked lists, Stack ADT, Stack Operations (Insertion and Deletion), Array Representation of Stacks, Stack Applications: Infix to postfix conversion, Tower of Hanoi.

Queues: Definition, Array Representation, Queue Implementation using arrays/lists and linked lists, Queue ADT, Operations on queues (Insertion and Deletion), Circular Queues and its operations, Priority Queues and its operations.

Module-4

Trees: Terminology, Binary Trees, Types of Binary trees, Properties of Binary trees, Array Representation of Binary Trees, Binary Tree Traversals – Inorder, Postorder, Preorder.

Binary Search Trees – Definition, Insertion, Deletion, Searching, Implementation of Binary tree, Heaps and Heap Sort, Construction of Expression Trees, AVL Trees.

Module-5

Graphs: Definitions, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search, DAG, Minimum Spanning Trees: Prim – Kruskal algorithm, Single Source Shortest Path: Weighted graphs, Dijkstra algorithm.

Course outcome (Course Skill Set)

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

1. Acquire knowledge of Python fundamentals and data structures.
2. Analyse and design of algorithms for Linked lists and sorting techniques.
3. Apply the concepts of Stacks and queues.
4. Utilize the operations of search trees and their applications.
5. Understand the concepts of Graphical algorithms.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Rance D Necaise "Data Structures and Algorithms using Python", Wiley, John Wiley and Sons.
2. Michael T. Goodrich, R. Tamassia and Michael H Goldwasser "Data structures and Algorithms
3. in python", Wiley student edition, John Wiley and Sons.
4. Narasimha Karumanchi "Data Structures and Algorithmic Thinking with Python",
5. CareerMonk Publications.

Web links and Video Lectures (e-Resources):

- http://www.nptelvideos.com/video.php?id=1442
- https://nptel.ac.in/courses/106105085/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Operating System		Semester	IV
Course Code	**22EA405C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the services provided by an operating system.
- Learn how processes are synchronized and scheduled.
- Identify different approaches of memory management and virtual memory management.
- Study the structure and organization of the file system
- Understand inter process communication and deadlock situations.

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

Module-1

Prerequisites: *Computer Organization and Architecture*

Introduction to Operating Systems: OS, Goals of an OS, Operation of an OS, Program's, Resource allocation techniques, Efficiency, System Performance and User Convenience, Classes of operating System, Batch processing, Multi programming, Time Sharing Systems, Real Time , distributed and modern Operating Systems.

Module-2

Process Management: OS View of Processes, PCB, Process States and Transitions, Threads, Kernel and User level Threads, Non-preemptive scheduling- FCFS and SRN, Preemptive Scheduling- RR and LCN, Long term, medium term and short term scheduling in a time sharing system.

Module-3

Memory Management: Static and Dynamic memory allocation, Contiguous Memory allocation, Non-Contiguous Memory Allocation, Paging, Segmentation, Segmentation with paging, Virtual Memory Management, Demand Paging, Paging Hardware, VM handler, Page replacement policies - FIFO, LRU

Module-4

File Systems: File systems and IOCS, Files and File Operations, Fundamental File Organizations, Directory structures, File Protection, Interface between File system and IOCS, Allocation of diskspace, Implementing file access, and File sharing schematics.

Module-5

Message Passing and Deadlocks: Overview of Message Passing, Implementing message passing, Mailboxes, Deadlocks, Deadlocks in resource allocation, Handling Deadlocks, Deadlock detection algorithm, Deadlock Prevention, Deadlock avoidance-Bankers algorithm.

Course outcome (Course Skill Set)

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

1. Summarize the goals, structure, operation and types of operating systems.
2. Apply scheduling techniques to find performance factors.
3. Apply suitable techniques for contiguous and non-contiguous memory allocation.
4. Interpret the organization of file systems and IOCS.
5. Describe message passing, deadlock detection and prevention methods.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 3. sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 7th edition, Wiley-India, 2006
2. Ann McHoes Ida M Fylnn, Understanding Operating System, Cengage Learning, 6th Edition
3. D.M Dhamdhere, Operating Systems: A Concept Based Approach 3rd Ed, McGraw- Hill, 2013.
4. P.C.P. Bhatt, An Introduction to Operating Systems: Concepts and Practice 4th Edition, PHI(EEE), 2014.
5. William Stallings Operating Systems: Internals and Design Principles, 6th Edition, Pearson.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106/105/106105214/
- https://www.youtube.com/watch?v=qJ_bXhrUOkc&t=12s

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

MICROWAVE ENGINEERING	
Course Code	**22EA502**
Teaching Hours/Week (L: T:P: S)	3:0:0:0
Total Hours of Pedagogy	40
Credits	03
Examination type (SEE)	Theory

Course objectives:

- 1.To analyze and study rectangular and circular wave guides using field theory.
- 2.To understand the theoretical principles underlying microwave devices and networks.
- 3.To design microwave components such as power dividers, hybrid junctions, Directional Couplers, microwave filters, Microwave Wave-guides and Components, Ferrite Devices.
- 4.To study about Microwave Solid-State Microwave Devices and Microwave Tubes.
- 5.To Study about Microwave Measurement Techniques.

Teaching-Learning Process (General Instructions)

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

Module-1

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnection of Two port networks, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behavior of Resistors, Capacitors and Inductors.

Module-2

Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Noise Figure, Constant VSWR, Broadband, High power and Multistage Amplifiers, Impedance matching using discrete components, Two component matching Networks, Frequency response and quality factor, T and Pi Matching Networks, Microstrip Line Matching Networks.

Module-3

Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub and quarter wave transformers. Crystal and Schottkey diode detector and mixers, PIN diode switch, Gunn diode oscillator, IMPATT diode oscillator and amplifier, Varactor diode, Introduction to MIC.

Module-4

Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Theory and application of Two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.

Module-5

Measuring Instruments : Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters.

Course outcome (Course Skill Set)

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

1. Explain different types of waveguides and their respective modes of propagation.
2. Analyze typical microwave networks using impedance, admittance, transmission and scattering matrix representations.
3. Design microwave matching networks using L section, single and double stub and quarter wave transformer.
4. Explain working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc.
5. Describe and explain working of microwave tubes and solid state devices.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. David M. Pozar – Microwave Engineering, 4th Edition, John Wiley & Sons, Inc. 2013
2. E C Jordan and K G Balmain - Electromagnetic Waves and Radiating Systems, 2nd Edition, PHI, 2003.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=F07ApLj12sE&list=PLwdnzlV3ogoUe3QVmRNzDTJYikG0lYjj-
- https://www.youtube.com/watch?v=it0Pwm0CnrM&list=PLwdnzlV3ogoUe3QVmRNzDTJYikG0lYjj-&index=3
- https://www.youtube.com/watch?v=7bjeIBiyWyM&list=PLwdnzlV3ogoUe3QVmRNzDTJYikG0lYjj-&index=9

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	-	-	-	1
CO2	3	3	3	2	2	1	-	-	-	-	-	1
CO3	3	3	3	2	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	3	3	3	2	2	1	-	-	-	-	-	1

SIGNAL PROCESSING	
Course Code	**22EA503**
Teaching Hours/Week (L:T:P: S)	4:0:0:0
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots
Credits	04
Examination nature (SEE)	Theory

Course objectives:

- Analyse the mathematical description of continuous and discrete time signals and systems.
- Analyse the signals in time domain using convolution sum and Integral.
- Determine the response of the LTI system to any input signal.
- Analyse Linear Time Invariant (LTI) systems in time and transform domains
- Apply the knowledge of frequency-domain representation and analysis concepts using Fourier analysis tools and Z-transform.

Teaching-Learning Process (General Instructions)

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

MODULE-1

Prerequisites: Probability

Random Variables: Random Variables, Several Random Variables, Statistical Averages (Mean, Moment, Central Moment, Mean Square Value, Characteristic Function, Joint Moments).

Random Processes: Random Processes, Stationary, Mean, Correlation, Covariance functions, Autocorrelation and its properties, Cross correlation and its properties, Ergodicity, Power Spectral Density and its properties.

Laboratory Sessions/ Experimental learning: To find the basis and properties of statistical averages and correlation.

MODULE-2

Continuous Time Signals and Systems: Introduction to continuous time and discrete time signals, Classification of signals with their mathematical representation and characteristics.

Transformation of independent variable, Introduction to various type of system, basic system

Laboratory Sessions/ Experimental learning: To define eigen values and eigen vectors using MATLAB

Applications: Communication systems,car stereo systems

Laboratory Sessions/ Experimental learning: To define eigen values and eigen vectors using MATLAB

Applications: Communication systems,car stereo systems

properties.

Analogous System:

Linear mechanical elements, force-voltage and force-current analogy,

MODULE-3

Time domain representation of LTI System: Impulse response, convolution sum. Computation of convolution sum using graphical method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular. LTI system Properties in terms of impulse response: System interconnection, Memory less, Causal, Stable, Invertible and Deconvolution and step response

Laboratory Sessions/ Experimental learning:

1. Exploring concepts with MATLAB- Generation of both continuous time and discrete time signals of various kinds.
    a) Plot $y(x) = x^2\cos(x)$, $g(x) = x\cos(x)$, $f(x) = 2^x\sin(x)$, $0 \leq x \leq 2\pi$ in the same figure.

Applications: Signal Processing, Control Theory, Communications Systems, Image and Video Processing, Biomedical Engineering (ECG, MRI), Oil extraction (Seismology), Music Industry (Audio) and Power Quality Analysis.

MODULE-4

Fourier Representation of aperiodic Signals: Introduction to Fourier Transform & DTFT, Definition and basic problems. Properties of Fourier Transform: Linearity, Time shift, Frequency shift, scaling, Differentiation and Integration, Convolution and Modulation, Parseval's theorem and problems on properties of Fourier Transform.

Laboratory Sessions/ Experimental learning:

1. To analyze the spectrum of the signal with Fourier transform using MATLAB. **Applications:** Image analysis, image filtering, image reconstruction and image compression.

MODULE-5

Prerequisites: Basics of Z-transform concepts

Z-Transforms: Concept of Z – Transform, Z – Transform of common functions, Inverse Z – Transform, Initial & Final value Theorems, Applications to solution of difference equations,

Properties of Z-transform.

Laboratory Sessions/ Experimental learning:

1. To compute Z-transform of finite duration sequence using MATLAB.
    a) Compute the z-transform of the sequence fx(n)-[-3,5,6,7,8], -2≤ n ≤ 2.
    b) Compute the z-transform of the discrete-time signal x(n)= n^2 u(n).
    c) Compute the convolution between the signals $X_1(z)$= z/z-0.9 and $X_2(z)$=z /z+6

Applications: To analysis of digital filters, Used to simulate the continuous systems, Analyse the linear discrete system, Used to finding frequency response, Analysis of discrete signal, Helps in system design and analysis and also checks the systems stability, For automatic controls in telecommunication.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	-	-	-	-	1	-	3
CO2	3	3	1	1	3	-	-	-	-	1	-	3
CO3	3	3	1	1	3	-	-	-	-	1	-	3
CO4	3	3	1	2	-	-	-	-	-	1	-	3
CO5	3	3	1	2	2	-	-	-	-	1	-	3

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

Sl.NO	Experiments
1	**Verification of sampling theorem**
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	Solving a given difference equation.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	I) Verification of DFT properties (like Linearity and Parseval's theorem, etc.) Ii)DFT computation of square pulse and Sinc function etc.
6	Design and implementation of FIR filter to meet given specifications (using different window techniques).
7	Design and implementation of IIR filter to meet given specifications
8	1. 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).
9	**Can be Demo experiments for CIE**
10	**Can be Demo experiments for CIE**
11	**Can be Demo experiments for CIE**
12	**Can be Demo experiments for CIE**

Course outcomes (Course Skill Set):

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

- Understand the basics of Linear Algebra.
- Develop input output relationship for linear time invariant system and understand the convolution operator for continuous and discrete time system.
- Analyse the properties of discrete time signals & systems.
- Determine the spectral characteristics of continuous and discrete time signal using Fourier transform.
- Compute Z-transforms, inverse Z- transforms and transfer functions of complex LTI systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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.

The IPCC means the 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**.

CIE for the theory component of the IPCC

- 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**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. 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.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory

component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.

- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she 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.

Suggested Learning Resources:

Books

1. **Alan V Oppenheim, Alan S. Willsky and A Hamid Nawab, "Signals & Systems", Pearson Education Asia/ PHI, 2nd Edition, 1997**
2. **B.P. Lathi, "Linear Systems and Integrals", Oxford University Press, 2005**
3. **Dr. D Ganesh Rao, "Digital Signal Processing", Pearson Education, 2nd Edition, 2011.**

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/117105134/

http://www.digimat.in/nptel/courses/video/108108109/L63.html

https://nptel.ac.in/courses/111106046/

https://nptel.ac.in/courses/111106111/

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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1	-	-	-	-	-	-	-	2
CO2	3	3	3	-	3	-	-	-	-	-	-	2
CO3	1		2	-	3	-	-	-	-	-	-	2
CO4	1			1	-	-	-	-	-	-	-	1
CO5	1			-	2	-	-	-	-	-	-	1

MACHINE LEARNING		Semester	V
Course Code	**22EA515A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Understand the basic theory of machine learning.
- To formulate machine learning problems related to different applications.
- To describe the range of machine learning algorithms along with their hypothesis.
- To apply the algorithm.

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

Module-1

Introduction to ML: Well posed learning problems, Designing a Learning system, Perspectives and Issues in Machine Learning.

Concept Learning: Introduction, A Concept Learning Task, Find S algorithm, Candidate Elimination algorithm, Inductive Bias.

Applications: Data training samples, Speech Recognition algorithm.

Laboratory Sessions/ Experimental learning:

1. Implement and demonstrate the FIND-S Algorithm for finding the most
2. specific hypothesis based on a given set of training data samples. Read the
3. training data from a .CSV file.

Module-2

Decision Tree Learning: Introduction, Decision Tree Representation, Appropriate Problems, Hypothesis Space Search, Inductive bias in decision tree, issues in Decision tree.

Instance Based Learning: Introduction, KNN, Locally Weighed Regression, Radial Basis Functions and Case Based Reasoning

Laboratory Sessions/ Experimental learning:

1. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Applications: Email Spam and Malware Filtering, ID3 algorithm, Self-driving cars

Module-3

Bayesian Learning: Introduction, Analyze Bayes theorem, Bayes theorem demonstration and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Optimal Bayes Classifier, Naive Bayes classifier, Bayesian belief networks, EM algorithm.

Laboratory Sessions/ Experimental learning:

1. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same dataset for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering

Applications: Virtual Personal Assistant, Online Fraud Detection.

Module-4

Artificial Neural Network: Introduction, Appropriate Problems, Perceptron, Multilayer Networks and Backpropagation algorithm.

Genetic Algorithms: Motivation, Genetic Algorithms, an illustrative example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Parallelizing Genetic Algorithms.

Laboratory Sessions/ Experimental learning:

1. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

Applications: Artificial Neural Network for building linear and non-linear networks.

Module-5

Analytical Learning: Introduction, Learning with perfect domain theories.

Combining inductive and analytical learning: Motivation, Inductive – Analytical Approaches to learning.

Reinforcement Learning: Introduction, The Learning Task, Q Learning

Real Time Applications: Design an algorithm / flowchart for Autonomous Vehicle, Image Recognition and Traffic Prediction.

Laboratory Sessions/ Experimental learning:

1. Implementation of game based om action reward strategy.

Applications: Gaming, NLP

Course outcome (Course Skill Set)

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

1. Choose the learning techniques and investigate concept learning.
2. Identify the characteristics of decision tree and solve problems associated with it.
3. Apply effectively neural networks for appropriate applications.
4. Apply Bayesian techniques and derive effectively learning rules
5. Evaluate hypothesis and investigate instant based learning and reinforced learning.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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).**

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

Suggested Learning Resources:

Books

3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013.
4. Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013
5. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.

Web links and Video Lectures (e-Resources):

- https//nptel.ac.in/courses/11706087/
- https://nptel.ac.in/courses/106/106/106106198/
- https://nptel.ac.in/courses/117102059/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**2**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**2**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**1**

CRYPTOGRAPHY		Semester	V
Course Code	**22EA515B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Outline the basic principles of Cyber security and its applications
- Familiarize with Cryptography and very essential algorithms.
- Use the theorems needed for cryptographic operations and compare & contrast different types of cryptography.
- State the concepts & uses of Digital signature and web security.
- Demonstrate the need and summarize the concept of Secure Electronic Transactions & Intrusion detection system.

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

Module-1

Introduction: Services, Mechanisms, Mechanism Attacks, The OSI Security Architecture, A Model for Network Security, Cyber Attacks, Defence Strategies and Techniques, Guiding Principles.

Mathematical Background of Cryptography: Integer Arithmetic, Modular Arithmetic, Matrices, The Greatest Comma Divisor, Useful Algebraic Structures, Chinese Remainder Theorem.

Applications: Time Stamping, Electronic Money, Secure Network Communication

Laboratory Sessions/ Experimental learning:

Breaking the Shift Cipher

Module-2

Basics of Cryptography: Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties.

Symmetric Ciphers: Symmetric Ciphers model, Substitution Techniques, Transposition Techniques, Simplified DES, Data encryption Standard (DES), The strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and modes of operation, Evaluation Criteria for Advanced Encryption standard, The AES Cipher.

Laboratory Sessions/ Experimental learning:

Breaking the Mono-alphabetic Substitution Cipher

Applications: wireless security, processor security, file encryption

Module-3

Block Cipher Operation: Electronic Codebook, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode

Public Key Cryptography: Principles of public key Cryptosystem, The RSA algorithms, Key management, Diffie – Hellman key exchange, Elgamal Cryptographic system, PRNG based on Asymmetric Cipher

Digital Signatures: Digital Signatures and Digital Signature Standard**.**

Laboratory Sessions/ Experimental learning:

Diffie-Hellman Key Establishment

Applications: Random number generator, permutation generator

Module-4

Key Management and Distribution: Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of Public keys, X.509 Certificates, Public key infrastructure.

Laboratory Sessions/ Experimental learning:

1. Digital Signatures Scheme

2. Cryptographic Hash Functions and Applications (HMAC)

Applications: Cyber-attacks, Cybercrime, Cyber security**.**

Module-5

Intruders, Intrusion Detection, Password Management, Malicious software programs – Viruses and related Threats, Virus Countermeasures

Firewall: Need of firewalls, Firewall Characteristics, Types of Firewalls, Design Principles, Trusted Systems

Laboratory Sessions/ Experimental learning:

Program for SSL operation.

Applications: Encryption, message authentication and integrity, and replay attack protection

Course outcome (Course Skill Set)

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

6. Analyse the importance of security attacks, service mechanism, basic network security model and its applications.
7. Design and develop simple cryptography algorithms and explain basic structure of DES and AES
8. Illustrate the concept public key cryptography & apply digital signatures in email
9. Describe different techniques used in key exchange protocols.
10. Analyzing various malicious software and firewalls.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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).**

13. The question paper will have ten questions. Each question is set for 20 marks.
14. 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.
15. The students have to answer 5 full questions, selecting one full question from each module.
16. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

6. Cryptography and Network Security- Behrouz A Forouzan, Debdeep Mukhopadhyay,Mc-GrawHill, 3rd Edition, 2015
7. Cryptography and Network Security- William Stallings, Pearson Education, 7th Edition.
8. Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=m4sjTt7rhow
- https://nptel.ac.in/courses/117101106/
- https://nptel.ac.in/courses/108108114/https://nptel.ac.in/courses/108105113/
- https://nptel.ac.in/courses/117106086/

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	-	1
CO2	3	3	3	2	1	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

Artificial Neural Networks		Semester	V
Course Code	**22EA515C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- To understand the biological neural network and to model equivalent neuron models.
- To understand the architecture, learning algorithm and issues of various feed forward and feedback neural networks
- To understand the architecture, learning algorithms
- To know the issues of various feed forward and feedback neural networks.
- To explore the Neuro dynamic models for various problems.

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

Module-1

Prerequisites: Linear Algebra, Statistics and Probability will smoothen the process of learning the surface of the subject

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation

Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

Laboratory Sessions/ Experimental learning: To find the basis and properties of statistical nature learning process.

Applications:

To make a successful stock prediction in real time a Multilayer Perceptron MLP (class of feedforward artificial intelligence algorithm) is employed.

Facial Recognition Systems are serving as robust systems of surveillance.

As CNN is used in image processing, the medical imaging data retrieved from tests is analyzed and assessed based on neural network models.

Laboratory Sessions/ Experimental learning:

Perceptron learning

The objective of this experiment is to illustrate the concept of perceptron learning in the context of pattern classification task. Following are the goals of the experiment:

To demonstrate the perceptron learning law.

To illustrate the convergence of the weights for linearly separable classes.

To observe the behavior of the neural network for two classes which are not linearly separable.

Module-2

Single Layer Perceptron's: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment

Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

Laboratory Sessions/ Experimental learning:

To Multilayer Feedforward Neural Networks

The objective of this experiment is to demonstrate the ability of a multilayer feedforward neural network (MLFFNN) in solving linearly inseparable pattern classification problems.

Applications: Perceptron is a linear classifier, and is used in supervised learning

Module-3

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

Laboratory Sessions/ Experimental learning:

How the choice of activation function effect the output of neuron experiment with the following function backpropagation purelin(n), bimary threshold(hardlim(n) haradlims(n)) ,Tansig(n) logsig(n)

Applications: The neural network is trained to enunciate each letter of a word and a sentence

It is used in the field of speech recognition

It is used in the field of character and face recognition.

Module-4

Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification

Laboratory Sessions/ Experimental learning:

Solution to Travelling Salesman Problem Using Self Organizing Maps

The objective of this experiment is to provide a suboptimal solution to the Travelling Salesman Problem (TSP), using the properties of self-organization feature maps (SOM). The focus is:

- To illustrate the principle of self-organization for addressing the travelling salesman problem
- To observe the suboptimal nature of the solution provided by SOM
- To study the effect of structure of SOM on the solution

Applications: One of the earliest and well-known applications of the SOM is the phonetic typewriter of Kohonen. It is set in the field of speech recognition, and the problem is to classify phonemes in real time so that they could be used to drive a typewriter from dictation.

Module-5

Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network

Paradigm Hopfield Models – Hopfield Models, Computer Experiment

Laboratory Sessions/ Experimental learning:

Hopfield Models for Solution to Optimization Problems

Weighted matching problem: Deterministic, stochastic and mean field annealing of a Hopfield model

The objective of this experiment is to demonstrate the use of Hopfield models for solving optimization problems. The main issue in solving optimization problems using neural networks is mapping of the problem to a neural network architecture. This experiment demonstrates how an optimization problem such as the graph bipartition problem, can be mapped on to an Hopfield model (feedback neural network).

Applications: Neural Network for Machine Learning Face Recognition using it Neuro-Fuzzy Model and its applications Neural Networks for data-intensive applications

Course outcome (Course Skill Set)

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

11. Create different neural networks of various architectures both feed forward and feed backward
12. Perform the training of neural networks using various learning rules
13. Perform the testing of neural networks and do the perform analysis of these networks for various pattern recognition applications.
14. Understand the similarity of Biological networks and Neural networks
15. Perform the training of neural networks using various learning rules.
16. Understanding the concepts of forward and backward propagations.
17. Understand and Construct the Hopfield models.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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).**

17. The question paper will have ten questions. Each question is set for 20 marks.
18. 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.
19. The students have to answer 5 full questions, selecting one full question from each module.
20. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

9. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
10. Artificial Neural Networks - B. Vegnanarayana Prentice Hall of India P Ltd 2005
11. Neural Networks in Computer Inteligance, Li Min Fu MC GRAW HILL EDUCATION 2003
12. Neural Networks -James A Freeman David M S Kapura Pearson Education 2004.
13. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/117/105/117105084/
- https://cosmolearning.org/courses/intelligent-systems-and-control/video-lectures/
- https://nptel.ac.in/courses/101104061
- https://scte-iitkgp.vlabs.ac.in/exp/neural-networks-perceptron/references.html

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

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	-	-	1	-	-	1
CO2	3	3	3	1	1	1	-	-	1	-	-	1
CO3	3	3	3	1	1	1	-	-	1	-	-	1
CO4	3	3	3	1	1	1	-	-	1	-	-	1
CO5	3	3	3	1	1	1	-	-	1	-	-	1

Cloud Computing and IOT Analytics		Semester	V
Course Code	**22EA515D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Discuss the concepts, characteristics, delivery models and benefits of cloud computing.
- Explore the key technical, organizational and compliance challenges of cloud computing.
- Grasp the concepts of virtualization efficiently. Gain knowledge on combination of functionalities and services of networking.
- Able to explain the definition and significance of the Internet of Things.
- Discuss the architecture, operation and business benefits of an IoT solution.

Teaching-Learning Process (General Instructions)

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

Module-1

Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Opensource software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.

Applications:

A cloud application is software that runs its processing logic and data storage between 2 different systems: client-side and server-side. Some processing takes place on an end user's local hardware, such as a desktop or mobile device, and some takes place on a remote server

Module-2

Cloud Computing: Application Paradigms: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre (Generic Routing Encapsulation) The Web application, Cloud for science and engineering, High performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing

Applications:

An application architecture describes the patterns and techniques used to design and build an application.

Module-3

Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization.

What is IoT: What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IoT Definitions, IoT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview

Applications:

Virtualization is technology that can be used to create virtual representations of servers, storage, networks, and other physical machines. Virtual software mimics the functions of physical hardware to run multiple virtual machines simultaneously on a single physical machine.

An IoT framework can be defined as a set of protocols, tools, and standards that provide a specific structure for developing and deploying IoT applications and services

Module-4

Fundamental IoT Mechanism and Key Technologies-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M, Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP), IPSO

Applications:

In many IoT based environs, RPL supports for low energy consumed communications. In IoT, several heterogeneous things are connected via the Internet. That is, sensors, smart devices, and cameras are IoT devices. In RPL, control messages are sent between nodes to give-and-take packets.

Module-5

Data and Analytics for IoT

Data Analytics for IoT – Introduction, Apache Hadoop, Using Hadoop-MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Realtime Data Analysis, Structural Health Monitoring Case Study**.**

Applications:

By applying IoT predictive analytics to a predictive maintenance model, companies can better understand the current condition of devices—as well as their future needs.

Course outcome (Course Skill Set)

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

1. Compare the strengths and limitations of cloud computing.
2. Identify the architecture, infrastructure and delivery models of cloud computing.
3. Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that. Choose appropriate schemes for the applications of IOT in real time scenarios.
4. Manage the Internet resources through different protocols used in each layer
5. Identify how IoT differs from traditional data collection systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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).**

21. The question paper will have ten questions. Each question is set for 20 marks.
22. 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.
23. The students have to answer 5 full questions, selecting one full question from each module.
24. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 201
2. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley, 2013.
3. Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017
4. Cloud Computing Implementation, Management and Security John W Rittinghouse, James F Ransome, CRC Press, 2013.

5.Computing Principles and Paradigms, Rajkumar Buyya , James Broberg, Andrzej

6. Goscinsk, i Willey, 2014.

Web links and Video Lectures (e-Resources):
• https://www.digimat.in/nptel/courses/video/106105166/L05.html • https://www.digimat.in/nptel/courses/video/106105166/L06.html • https://www.digimat.in/nptel/courses/video/106105166/L09.html • https://www.digimat.in/nptel/courses/video/106105166/L55.html • https://www.digimat.in/nptel/courses/video/106105166/L56.html
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	**3**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO 2	**3**	**-**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO 3	**3**	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	**-**
CO 4	**3**	**3**	**1**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**2**	**-**
CO 5	**2**	**2**	**3**	**3**	**3**	**2**	**-**	**-**	**2**	**2**	**2**	**2**

Antenna and Wave Propagation		Semester	
Course Code	**22EA601**	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	04	Exam Hours	
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

1) To understand the applications of electromagnetic waves in free space.
2) To introduce working principles of various antenna types.
3) To discuss major applications of antennas with an emphasis on how antennas are employed.
4) To understand the concept of radiation Mechanism parameters, current distributions and antenna arrays
5) To understand the concept of wave propagation in various layers and losses due to earth effects

Teaching-Learning Process (General Instructions)

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

1. **Group discussion, MCQ, Pooling question**

MODULE-1

Antenna Fundamentals

Antenna Parameters - Radiation Patterns and Mechanism, Patterns in Principal Planes, Main Lobe and Side Lobes, Beam widths, Polarization, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency, Effective Height, Illustrated problems.

Thin Linear Wire Antennas:

Potential function and electromagnetic field: Heuristic Approach, Maxwell Equation approach, Potential function for time periodic fields, Radiation from an oscillating Dipole and alternating current element, The Hertzian Dipole.

Video link / Additional online information: https://youtu.be/t-AP3ya8Pao

Antennas - Course (nptel.ac.in) (By Prof.Girish Kumar-IIT-Bombay)

MODULE-2

Antenna Arrays

Two element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End fire Arrays, EFA with Increased Directivity, Derivation of their characteristics and comparison; Concept of Scanning Arrays, Directivity Relations (no derivations). Related Problems. Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Design Relations. Arrays with Parasitic Elements, Yagi-Uda Arrays, Smart antennas.

Video link / Additional online information: https://youtu.be/t-AP3ya8Pao

Antennas - Course (nptel.ac.in) (By Prof.Girish Kumar-IIT-Bombay)

MODULE-3

Non-Resonant Radiators

Introduction, Traveling wave radiators – Basic concepts, Long wire antennas – Field strength calculations and Patterns, Micro Strip Antennas-Introduction, Features, Advantages and Limitations. Rectangular Patch Antennas –Geometry and Parameters, Impact of different parameters on characteristics. Broadband Antennas: Helical Antennas – Significance, Geometry, Basic properties. Design considerations for mono-filer helical antennas in Axial Mode and Normal Modes (Qualitative Treatment).

Video link / Additional online information: https://youtu.be/t-AP3ya8Pao

Antennas - Course (nptel.ac.in) (By Prof.Girish Kumar-IIT-Bombay)

MODULE-4
VHF, UHF and Microwave Antennas Reflector Antennas: Flat Sheet and Corner Reflectors. Paraboloidal Reflectors – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Off-set Feeds, Cassegrain Feeds. Horn Antennas– Types, Optimum Horns, Design Characteristics of Pyramidal Horns; Lens Antennas – Geometry, Features, Dielectric Lenses and Zoning, Applications, Antenna Measurements – Patterns Required, Set Up, Distance Criterion, Directivity and Gain Measurements (Comparison, Absolute and 3-Antenna Methods). **Video link / Additional online information: https://youtu.be/t-AP3ya8Pao** Antennas - Course (nptel.ac.in)(By Prof.Girish Kumar-IIT-Bombay)
MODULE-5
WAVE PROPAGATION Concepts of Propagation – Frequency ranges and types of propagations. Friis Free Space Equation, Reflection of radio waves from plane surface of earth, Reflection coefficient for horizontal and vertical polarization, Ground Wave Propagation–Field strength, Attenuation Characteristic for vertical and Horizontal polarized wave, Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF Calculations for flat and spherical earth cases. Video link / Additional online information: **https://youtu.be/t-AP3ya8Pao** Antennas - Course (nptel.ac.in)(By Prof.Girish Kumar-IIT-Bombay)

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

Sl.NO	Experiments
1	Measurement of attenuation by using microwave test bench.
2	Determination of Coupling and isolation characteristics of microstrip directional
3	Study of Isolator. Extraction of S- parameters.
4	Study of Circulator. Extraction of S- parameters
5	Study the I-V Characteristics of Gunn Diode.
6	Reflex klystron X-Y Characteristic
7	Design of a monopole antenna

8	Design of a Dipole Antenna
9	Measurement of directivity and gain of microstrip Yagi antennas.
10	Design of Rectangular and circular Microstrip Patch Antenna
11	Design of horn antenna
12	Design of a Parabolic Reflector Antenna

Course outcomes (Course Skill Set):

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

- . Acquire knowledge of basic antenna parameters
- Design and analyze wire antennas, loop antennas, reflector antennas, lens antennas, horn antennas and micro-strip antennas.
- Analyze the field patterns radiated by various types of antennas.
- Understand the working and characteristics of antenna arrays.
- Compute several antenna parameters to assess antenna's performance.

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). The student is declared as a pass in the course if he/she 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.

The IPCC means the 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**.

CIE for the theory component of the IPCC

- 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.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she 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.

Suggested Learning Resources:

Books

1. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, 3rdEdition, TMH, 2003.
2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd Edition, 2000.
3. Antennas and Wave Propagation – K.D. Prasad, SatyaPrakashan, Tech India Publications, New Delhi, 2001.
4. Antenna Theory - C.A. Balanis, John Wiley and Sons, 2ndEdition, 2001.
5. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, vol. 5, Standard Publishers Distributors, Delhi.

Web links and Video Lectures (e-Resources):

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

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

CO-PO/PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	3	3	2	-	-	2	-	1	-
CO3	3	2	1	3	-	2	-	-	2	-	-	-
CO4	3	3	2	3	3	2	-	-	2	2	2	-
CO5	3	2	3	3	3	2	-	-	2	2	2	2

Optical Communication		Semester	
Course Code	**22EA602**	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	04	Exam Hours	
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- The functionality of each of the components that comprise a fiber-optic communication system .
- The properties of optical fiber and The principles of single and multi-mode optical fibers and their characteristics.
- The operation of LEDs, laser diodes, and PIN photo detectors (spectral properties, bandwidth, and circuits) and apply in optical systems.
- The concept of power launch to Optical analog and digital receiver
- The concepts of optical system design and WDM

Teaching-Learning Process (General Instructions)

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

2. **Group discussion, MCQ, Pooling question**

MODULE-1

Overview of optical fiber communication - Historical development, The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems

MODULE-2

FIBER MATERIALS:

Glass, Halide, Active glass, Chalgenide glass, Plastic optical fibers. Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay.

MODULE-3

OPTICAL FIBER CONNECTORS-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints.

OPTICAL SOURCES AND DETECTORS:

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical detectors-Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.

MODULE-4

Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers.

MODULE-5

Optical system design - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.

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

After going through this course the student will

- Choose necessary components required in modern optical communication systems.
- Design and build optical fiber experiments in laboratory, and learn how to calculate electromagnetic modes in wave guides, the amount of light lost going through an optical system, dispersion of optical fibers.
- Use different types of photo detectors and optical test equipment to analyze optical fiber and light wave systems.
- Choose the optical cables for better communication with minimum losses.
- Design, build and demonstrate optical fiber experiments in the laboratory

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). The student is declared as a pass in the course if he/she 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.

The IPCC means the 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**.

CIE for the theory component of the IPCC

- 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**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. 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.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- The student is declared as a pass in the course if he/she 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.

Suggested Learning Resources:

Books

1. Optical Fiber Communications – Gerd Keiser, McGraw-Hill International edition, 3rd Edition, 2000.
2. Optical Fiber Communications – John M. Senior, PHI, 2nd Edition, 2002.

REFERENCES:

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education,2005.
2. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Ediition, 2004.
3. Fiber Optic Communications – Joseph C. Palais, 4th Edition, Pearson Education, 2004

Web links and Video Lectures (e-Resources):

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

https://youtu.be/t-AP3ya8Pao

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

Course Outcome

After going through this course the student will

1. Choose necessary components required in modern optical communication systems.
2. Design and build optical fiber experiments in laboratory, and learn how to calculate electromagnetic modes in wave guides, the amount of light lost going through an optical system, dispersion of optical fibers.
3. Use different types of photo detectors and optical test equipment to analyze optical fiber and light wave systems.
4. Choose the optical cables for better communication with minimum losses.
5. Design, build and demonstrate optical fiber experiments in the laboratory.

CO-PO/PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	3	3	2	-	-	2	-	1	-
CO3	3	2	1	3	-	2	-	-	2	-	-	-
CO4	3	3	2	3	3	2	-	-	2	2	2	-
CO5	3	2	3	3	3	2	-	-	2	2	2	2

Semester: VI		
SATELLITE COMMUNICATION		
Course Code:	**22EA613A**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Provide a conceptual knowledge of communication through satellites.	
2	Study of electronic systems associated with a satellite and the earth station.	
3	Understand typical challenges of satellite-based systems.	
4	Study satellite applications focusing various domains services such as remote sensing, weather forecasting and navigation.	
5	Learn the basic principle of radar equation.	

UNIT 1	
Prerequisites: Digital Communication Systems **Introduction to Satellite Communication:** Orbital aspects of Satellite Communication, Introduction to geo-synchronous and geo-stationary satellites, Kepler's laws, Locating the satellite with respect to the earth, Sub-satellite point, Look angles, Mechanics of launching a synchronous satellite. **Laboratory Sessions/ Experimental learning:** 1. To study the details regarding satellite communication toolbox in Matlab. **Applications:** DTH, or satellite television, services (such as the DirecTV and DISH Network services **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://youtu.be/n70zjMvm8L0 3. https://youtu.be/oYRMYSlVj1o	**8Hrs.**
UNIT 2	
Elements of Communication Satellite Design: Satellite subsystems - Attitude and orbit control electronics - Telemetry and tracking - Power subsystems - Communication subsystems - Satellite antennas - Reliability and redundancy- Frequency modulation techniques. **Digital Transmission Basics -** Multiple access techniques – FDMA, TDMA, CDMA, SDMA, ALOHA and its types – Onboard processing- Satellite switched TDMA – Spread spectrum transmission and reception for satellite networks. **Laboratory Sessions/ Experimental learning:** 1. Investigate the design elements that ensure high reliability and fault tolerance in satellite	**8Hrs.**

communication systems. Consider redundancy mechanisms, power backup systems, and error correction techniques to minimize system downtime. **Applications:** Mobile Communication **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://vvvnu.youtube.com/watch?v=FTHt-c8hWKw	
UNIT 3	
Satellite Link Design: Basic transmission theory – System noise temperature and G/T Ratio- Noise figure and noise temperature- Calculation of system noise temperature – G/T ratio for earth stations - Link budgets - Uplink and downlink budget calculations - Error control for digital satellite links - Prediction of rain attenuation and propagation impairment counter measures. **Laboratory Sessions/ Experimental learning:** 1.Perform a link budget analysis for a satellite communication system operating in the Ku-band frequency range. Consider the transmitter power, antenna gain, path loss, rain attenuation, and receiver sensitivity to determine the link performance and **Applications:** Error detection and correction **Video link /Additional online information:** **3.** https://www.digimat.in/nptel/courses/video/117105131/L13.html **4.** https://www.digimat.in/nptel/courses/video/117105131/L14.html	**8Hrs.**
UNIT 4	
Remote Sensing Satellites: Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications. **Weather Forecasting Satellites:** Fundamentals, Images, Orbits, Payloads, Applications. **Navigation Satellites:** Development of Satellite Navigation Systems, GPS system, Applications. **Laboratory Sessions/ Experimental learning:** 1. A Case Study of Using Remote Sensing Data and GIS for Land Management **Applications:** Communication, Weather forecasting, Remote sensing, Navigation **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://nptel.ac.in/courses/121/107/121107009/ **3.** https://onlinecourses.nptel.ac.in/noc19_ce45/preview	**8Hrs.**
UNIT 5	

Introduction to Radar: Radar block diagram and operation, Radar frequencies, Applications of radar, Prediction of range performance, Minimum detectable signal, Receiver noise, Probability density function, SNR, Integration of radar pulses, Radar cross-section of targets, PRF and range ambiguities, Transmitter power, System losses. **Radar Technology and Applications:** Doppler Effect, CW radar, FM CW radar, Multiple frequency CW radar, MTI radar. **Laboratory Sessions/ Experimental learning:** 1. Implement the radar range equations for remote sensing. **Applications:** Ground surveillance, missile control, fire control, air traffic control (ATC), moving target indication (MTI). **Video link / Additional online information:** **1.** https://onlinecourses.nptel.ac.in/noc19_ee58/preview **2.** https://nptel.ac.in/courses/108/105/108105154/	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the satellite orbits and its trajectories with the definitions of parameters associated with it.
CO2	Comprehend the design of satellite subsystems
CO3	Evaluate spacecraft subsystem performance and trades
CO4	Understand the functioning of satellites for communication, remote sensing, and weather and navigation applications.
CO5	Model the characteristics of radar echoes from different types of targets and clutter.

Reference Books:	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt, “Satellite Communication”, 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
2.	Anil K Maini, Varsha Agrawal, Satellite Communication, Wiley India Pvt. Ltd., 2015, ISBN: 978-81265-2071-8.
3.	Merril. I. Skolnik, “Introduction to Radar Systems”, 2/e, MGH, 1981.
4.	Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Semester: VI		
Network and Cyber Security (Theory)		
Course Code:	**22EA613B**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Know about security concerns in Email.	
2	Understand the security factors in Internet Protocol.	
3	Understand cyber security concepts.	
4	List the problems that can arise in cyber security.	
5	Discuss the various cyber security frame work.	

UNIT 1	
Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH) **Laboratory Sessions/ Experimental learning:** 1. Study of HTTP client server 2. Study of SSH session with a laboratory router **Applications:** Encrypting the communication between web applications and servers, in VOIP, Video, Audio. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=tcQQ9A8M2L0 2. https://www.youtube.com/watch?v=LcdlBTYe6vo	8Hrs.
UNIT 2	
E-mail Security: Pretty Good Privacy, S/MIME, Domain keys identified mail **Laboratory Sessions/ Experimental learning:** 1. Study "How to make strong passwords" and "passwords cracking techniques". 2. Analysis of the security vulnerabilities of E-Mail Application. **Applications:** Security of confidential data, Improve spam and phishing protection for mail. **Video link / Additional online information:** 1. https://archive.nptel.ac.in/courses/106/106/106106234/ 2. https://heimdalsecurity.com/blog/email-security/	8Hrs.
UNIT 3	
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations Internet Key Exchange. Cryptographic Suites	8Hrs.

Laboratory Sessions/ Experimental learning: **1.** Study the steps to hack a strong password. **2.** Study the Kali Tools for Cryptography. **Applications:** Remote Internet Access security. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=ipQkQopBLfU 2. https://www.youtube.com/watch?v=gtFZMvqXD1g	
UNIT 4	
Cyber network security concepts: Security Architecture, anti pattern: signature based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. Refactored solution: reputational, behavioural and entropy based malware detection. The problems: cyber anti patterns concept, forces in cyber anti patterns, cyber anti pattern templates, cyber security anti pattern catalog **Laboratory Sessions/ Experimental learning:** 1. Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures. 2. Demonstrate intrusion detection system (ids) using any tool (snort or any other s/w) **Applications:** Network and software security, Security against DDOS **Video link / Additional online information :** 1. https://www.simplilearn.com/tutorials/cyber-security-tutorial/what-is-cyber-security 2. https://onlinecourses.nptel.ac.in/noc23_cs127/preview	8Hrs.
UNIT 5	
Cyber network security concepts contd. : Enterprise security using Zachman framework Zachman framework for enterprise architecture, primitive models versus composite models, architectural problem solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings. Case study: cyber security hands on – managing administrations and root accounts, installing hardware, reimaging OS, installing system protection/ antimalware, configuring firewalls **Laboratory Sessions/ Experimental learning:** 1. Analysis the Security Vulnerabilities of E-commerce services. **Applications:** Security of enterprise applications.	8Hrs.

Video link / Additional online information: 1. https://www.youtube.com/watch?v=PHTGKqj8L0U 2. https://www.youtube.com/watch?v=lWMaUc1rJgM	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain network security protocols
CO2	Understand the basic concepts of cyber security
CO3	Discuss the cyber security problems
CO4	Explain Enterprise Security Framework
CO5	Apply concept of cyber security framework in computer system administration

Reference Books:	
1.	William Stallings, Cryptography and Network Security Principles and Practice, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-3251877-3.
2.	Thomas J. Mowbray, Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions, Wiley.
3.	Cryptography and Network Security, Behrouz A. Forouzan, TMH, 200
4.	Cryptography and Network Security, Atul Kahate, TMH, 2003

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions,

one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Semester: VI		
VIRTUAL & AUGMENTED REALITY (Theory)		
Course Code:	**22EA613C**	**CIE Marks:50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Establish and cultivate a broad and comprehensive understanding of the virtual reality and Augmented Reality.	
2	Exhibit various elements and components used in AR/VR Hardware	
3	Provide various factors involved in multisensory action of human being	
4	Provide a detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR/AR modelling and programming.	
5	Understand virtual reality, augmented reality and using them to build Biomedical, engineering and robotics application.	

Module-1	**8Hrs.**
Prerequisites: *Intermediate programming ability in object-oriented languages, Basic linear algebra*	

Introduction to Immersive Technologies: A Brief History of Virtual Reality, The five Classic Components of a VR System, Early Commercial VR Technology , VR becomes an Industry, Reality, Virtuality and Immersion , VR, AR, MR, xR: similarities and differences. **Laboratory Sessions/ Experimental learning:** 1. Choose an existing VR application and write a summary including a personal critical reflection on its look and feel especially in relation to immersion, presence, agency and interactivity. **Applications:** VR in Sport**,** Mental Health**,** Medical Training. **Video link / Additional online information:** https://nptel.ac.in/courses/121/106/121106013/	
Module-2	
Motion Tracking and Navigation: Position and Motion Trackers , Inside Out/Outside In , Tracker Performance Parameters , Optical, Active and Passive Trackers , Inertial and Hybrid Trackers, HMD Trackers , Magnetic Trackers , Mechanical Trackers , Ultrasonic Trackers , Navigation and Manipulation Interfaces , Tracker-Based Navigation/Manipulation Interfaces. **Laboratory Sessions/ Experimental learning:** 1. Design an immersive environment in Unity-3D or Unreal that will develop and enhance Work in groups. Start by building a simple 3D world that an interactive player can move around in. Connect the controllers and create a simple interaction loop. Measure velocity, acceleration, distances, and other motion and spatial parameters of the user and the controllers. **Applications:** Industrial Training and Simulation, Flight Training and Simulation, Pilot Head Tracking, Live Aircraft, Sports motion Analysis. **Video link / Additional online information:** https://nptel.ac.in/courses/106/106/106106138/	**8Hrs.**
Module-3	
The Human behind the lenses: Human Perception and Cognition , The Human Visual System, VR Health and Safety Issues, Effects of VR Simulations on Users , Cyber sickness, before and now Guidelines for Proper VR Usage. **Laboratory Sessions/ Experimental learning:** 1. Create a well-rounded multisensory action that is meaningful, safe and accommodates all senses, visual, auditory and tactile. **Applications:** Human–Computer Interaction**,** e-Sports, Games**,** Cultural heritage **Video link / Additional online information:**	**8Hrs.**

https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/	
Module-4	
Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems. **Laboratory Sessions/ Experimental learning:** 1. Experiment with Photo grammetry and improve the visual look and feel of your environment **Applications:** Healthcare **Video link / Additional online information:** https://www.coursera.org/learn/ar-technologies-video-streaming	**8Hrs.**
Module-5	
Medical Applications of xR: Behavioural Therapy, Virtual and Augmented Surgery, Triage and Diagnostics, Applications of VR in Robotics: Robot Programming, Robot Tele operation. **Laboratory Sessions/ Experimental learning:** 1. Add a training component to your existing prototype. Define the mechanics that will progressively improve user's performance to mastery through an interaction loop using the dual concept of challenge / reinforcing. **Video link / Additional online information:** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5622235/	**8Hrs.**

Course outcomes:	
CO1	Acquire various principles and concepts of virtual reality and its application.
CO2	Understand the optical motion tracking and navigation in virtual reality.
CO3	Analyse and solve problems related to their expertise in Augment and Virtual Environments.
CO4	Develop detailed analysis of the engineering, scientific and functional aspects of VR systems and the fundamentals of VR modelling and programming.
CO5	Illustrate the knowledge of integrating hardware, software, tools for AR/VR technology.
Text Books:	
2.	C. Burdea and Philippe Coiffet, "Virtual Reality Technology", First Edition, Gregory, John Wiley and Sons, Inc.,2008
3.	Steven M. LaValle, "Virtual Reality", 2016. Online version: http://msl.cs.uiuc.edu/vr/

4.	Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, First Edition, 2013.
5.	Dieter Schmalstieg and Tobias Hollerer, “Augmented Reality: Principles and Practice (Usability)” by Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
Reference Books:	
1.	Jason Jerald.,“The VR Book: Human-Centred Design for Virtual Reality”, Association for Computing Machinery and Morgan and Claypool, New York, NY, USA, First Edition, 2015
2.	Steve Aukstakalnis, “Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)”, Addison-Wesley Professional; 1st edition, 2016.
3.	Robert Scoble and Shel Israel, “The Fourth Transformation: How Augmented Reality and Artificial Intelligence Will Change Everything”, Patrick Brewster Press; 1st edition, 2016.
4.	Tony Parisi, “Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile”, OReilly Media; 1st edition, 2015.
5.	Tony Parisi, “Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages”, OReilly Media; 1st edition, 2014.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a

maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Semester:VI		
Digital Image Processing		
Course Code:	**22EA613D**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Learn the fundamentals of digital image processing	
2	Understand the image transforms and other image enhancement techniques used in digital image processing.	
3	Study the image restoration techniques and methods used in digital image processing	
4	Understand region-based segmentation, representation and descriptions	
5	Know the color fundamentals and various morphological image processing techniques	

UNIT 1	
Prerequisites: *Discrete Fourier Transform, MATLAB Basics* **Introduction to Digital Image Processing:** What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization **Applications of Image Processing:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB **Applications:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** **1.** https://nptel.ac.in/courses/117/105/117105079/ **2.** https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 2	
Image Enhancement in the Spatial Domain: Some Basic Relationships Between Pixels, Linear and	**8Hrs.**

Nonlinear Operations, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
UNIT 3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering **Laboratory Sessions/ Experimental learning:** **1.** Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 4	
Segmentation: Point, Line, and Edge Detection: Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Advanced Technique for Edge Detection, Thresholding: Optimum Global Thresholding Using Otsu's Method, Region-Based Segmentation: Region growing, Region splitting and merging	**8Hrs.**

Representation and Description: Representation, Boundary descriptors. **Laboratory Sessions/ Experimental learning:** **1.** Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2 . https://www.tutorialspoint.com/dip/index.htm	
UNIT 5	
Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing. **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**

Course Outcomes: After completing the course, the students will be able to

CO1	Analyze image processing algorithms used for sampling and quantization.
CO2	Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
CO3	Implement and analyse various image restoration algorithms
CO4	Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
CO5	Conduct independent study and analyze various Morphological Image Processing techniques.

Text Books:

1.	Rafel C Gonzalez and Richard E. Woods, "Digital Image Processing"-, PHI 3rd Edition, 2010.
2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, —"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, Fourth Edition, 2013, ISBN: 978-81-315-1883-0

Reference Books:

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	1	-	-	1
CO2	3	3	3	2	2	1	-	-	1	-	-	1
CO3	3	3	3	2	2	1	-	-	1	-	-	1
CO4	3	3	3	2	2	1	-	-	1	-	-	1
CO5	3	3	3	2	2	1	-	-	1	-	-	1

Semester:VI		
Real Time Operating Systems		
Course Code:	**22EA654A**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Acquire knowledge about concepts related to OS for Embedded Systems.	
2	Gain knowledge about different types of scheduling algorithms suitable for embedded real time systems.	
3	Introduce the principles of Inter process communication and multitasking applications.	
4	Explain the architecture of Linux Kernel and RTOS applications to Linux.	
5	Discuss Real-Time Programming in Linux and µC linux	

Module-1	
Prerequisites: *Basic Concepts of Operating systems and basics of task management and task scheduling.* **Real Time Systems:** Introduction, issues in real time computing, Structure of a real time system, task classes, performance measures for real time systems, task assignment and scheduling algorithms, mode changes, Fault tolerant scheduling, Real Time Models. **Laboratory Sessions/ Experimental learning:** 1. Create an application that creates two tasks that wait on a timer whilst the main task loops. 2. Create an application that creates tasks and scheduling tasks. **Applications:** Kiel RTOS for ARM (Keil RTX - ARM) **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105036/	**8Hrs.**
Module-2	
µC/OS- II RTOS Concepts: Foreground/Background process, Resources, Tasks, Multitasking, Priorities, Schedulers, Kernel, Exclusion, Inter task communication, Interrupts, Clock ticks, µC/OS-II Kernel structure , µC/OS- II Initialisation, Starting µC/OS- II. **Laboratory Sessions/ Experimental learning:** 1. Write an Keil RTOS code that demonstrates the multitasking priority. 2. Write an Keil RTOS code that assigns priority and sets the time slice period to	**8Hrs.**

illustrate time slicing. **Applications:** 1. Email Spam and Malware Filtering 2. File Managers and Resource management systems **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106198/ http://www.nptelvideos.in/2012/11/real-time-systems.html	
Module-3	**8Hrs.**
µC/OS- II RTOS Functions: Task Management, Time management, Semaphore management, Mutual exclusion semaphore, Event Management, Message management, Memory management, porting µC/OS- II – comparison and study of various RTOS like QNX- VX Works-Psos. **Laboratory Sessions/ Experimental learning:** **1.** Write an Keil RTOS code to manage tasks to handle semaphore to overcome mutual exclusion. **2.** Demonstrate Porting of µC/OS- II in Embedded processor. **Applications:** Traffic light controller system **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105215/ https://nptel.ac.in/courses/106/105/106105172/	
Module-4	**8Hrs.**
Embedded Linux: Embedded Linux, Features - Embedded Linux Distributions -Architecture of Embedded Linux - Linux Kernel Architecture – User Space -Root File System - Linux Start-Up Sequence - GNU Cross Platform Tool chain -Porting Traditional RTOS Applications to Linux. **Laboratory Sessions/ Experimental learning:** 1. Write an application that display two different messages in LCD display in two lines. **Applications:** Smart Mobile Phone operating system development process demonstration. **Video link / Additional online information:** 1. http://1.https//nptel.ac.in/courses/11706087/ https://nptel.ac.in/courses/106/106/106106198/	
Module-5	**8Hrs.**
Real time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux - Building and Debugging, Building the Kernel, Integrated Development Environment, Kernel Debuggers, Embedded Drivers, Boardsupport packages, Introduction to µC linux.	

Laboratory Sessions/ Experimental learning: 1. Creating and UART driver for USB bus. **Applications:** Demonstration of ABS system in automobiles **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/ 2. http://www.nptelvideos.in/2012/11/real-time-systems.html https://www.youtube.com/watch?v=HlU5cYqGLZE	

Course outcomes:	
CO1	Summarize fundamental principles for programming of real time systems with time and resource limitations.
CO2	Develop RTOS based embedded real time applications.
CO3	Analyze the functions of real time operating systems .
CO4	Utilize RTOS software tool chain for Embedded Applications.
CO5	Develop real time kernals and Embedded Drivers.
Text Books:	
1.	Krishna C.M., Kang G. Shin, "Real Time Systems", Tata McGraw-Hill Edition, 2010.
2.	Philip A.Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition-IEEE Press, IEEE Computer Society Press, 2001.
Reference Books:	
1.	Jean J Labrosse, "MicroC/OS-II The Real Time Kernel" II Edition, CMP Books, 2002.
2.	P.Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development",Auerbach Publications, Taylor& Francis Group, 2006.
3.	Christopher Hallinan, "Embedded Linux Primer, A Practical, Real-World Approach", II Edition PearsonEducation, Inc., 2011.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The

number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**1**
CO3	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**1**

High-3, Medium-2, Low-1

Semester:VI		
Sensor Technology		
Course Code:	**22EA654B**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand various technologies associated in manufacturing of sensors	
2	Provide better familiarity with different sensors and their applications in real life.	
3	Acquire knowledge about types of sensors used in modern digital systems.	
4	Evaluate the technological and physical limitations of a specific sensor.	
5	Propose a suitable sensor for a given measurement situation.	

Module-1	
Prerequisite: *Basic Electronics, Knowledge on physical quantities* **Sensors Fundamentals and Characteristics:** General Concepts and Terminology, Sensor Classification, Static Characteristics, Dynamic Characteristics, Materials for Sensors, Microsensor Technology. **Laboratory Sessions/ Experimental learning:** 1. Study on applications of sensors **Applications:** Biological, Chemical, Electric, magnetic, or electromagnetic wave, Heat, temperature, Mechanical displacement or wave, Radioactivity, radiation and other. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105064/ https://nptel.ac.in/courses/108/108/108108147/	**8Hrs.**
Module-2	
Primary sensors: Temperature sensors, Pressure sensors, Flow-velocity and flow-rate sensors, Level sensors, Force and torque sensors, Acceleration and inclination sensors and Velocity sensors. **Resistive Sensors:** Resistive Temperature Detectors (RTDs),Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas sensors. **Laboratory Sessions/ Experimental learning:** 1. Strain measurement with Bridge circuit **Applications:** Patient monitoring in medical applications, Manufacturing and industrial equipment	**8Hrs.**

and motorsport applications. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105064/ https://nptel.ac.in/courses/108/106/108106165/	
Module-3	**8Hrs.**
Reactance Variation and Electromagnetic Sensors: Capacitive sensors: Variable capacitor and Differential capacitor**,** Inductive sensors:Variable reluctance sensors, Eddy current sensors, Linear Variable Differential Transformers (LVDTs), Electromagnetic sensors: Sensors based on Faraday's Law and Hall effect sensors. **Laboratory Sessions/ Experimental learning:** 1. Develop a displacement measurement system with inductive sensors (LVDT) **Applications:** Smart phones, Industrial automation, Communication, automobile and aerospace. **Video link / Additional online information:** https://nptel.ac.in/courses/108/105/108105064/	
Module-4	**8Hrs.**
Self-Generating sensors: Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors, Proximity sensors. **Laboratory Sessions/ Experimental learning:** 1. Develop a sensor system for force measurement using piezoelectric sensors **Applications:** Temperature controlled devices: refrigeration and air conditioning, Alarm clocks, Medical devices, PIN pads, photonics and pharmaceutical compositions, Robotics. **Video link / Additional online information:** https://nptel.ac.in/courses/108/105/108105064/	
Module-5	**8Hrs.**
Digital sensors: Position encoders,Resonant sensors: SAW sensors, Vibrating wire strain gages, Vibrating cylinder sensors, Digital flow meters **Other sensing methods:** Charge-Coupled sensors – Fundamentals & types of CCD, Fiber-Optic sensors, Ultrasonic-based sensors, Gyroscope sensors, optical sensors, IR sensors. **Laboratory Sessions/ Experimental learning:** 1. Measure strain, temperature and pressure using LabVIEW. **Applications:** Industries, digital cameras, photocopiers. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105064/ https://nptel.ac.in/courses/112/103/112103174/	

Course outcomes:	
CO1	Understand the concept of sensors and its characteristics.
CO2	Explain the working principles of primary and resistive sensors.
CO3	Understand the inductive, capacitive and Electromagnetic sensors and its applications
CO4	Identify alternative methods to measure common quantities such as temperature, pressure, force and acceleration.
CO5	Select appropriate sensors used for various applications
Text Books:	
4.	Ramon Pallas & John G.Webster, "Sensors and signal conditioning", John Wiley & Sons., 2nd Ed.,2001.
5.	J. Fraden, "Handbook of Modern Sensors: Physical, Designs, and Applications", AIP Press, Springer, 3rd Ed.,2004.
Reference Books:	
1.	D. Patranabis, "Sensors and Transducers", PHI Publication, 2nd Ed.,2004 New Delhi.
2.	Webster John G, "Instrumentation and sensors Handbook", CRC Press, 1st Ed., 1999.
6.	Shawhney A.K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 1994.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	-	2	-	-	-	-	2	1
CO2	3	2	2	1	1	2	-	-	-	-	2	1
CO3	3	2	2	1	1	2	-	-	-	-	2	1
CO4	3	2	2	1	1	2	-	-	-	-	2	1
CO5	3	2	2	1	2	2	-	-	-	-	2	1

High-3, Medium-2, Low-1

Semester:VI		
Principles of Communication Systems		
Course Code:	**22EA654C**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand and analyze the concepts of Analog Modulation schemes viz; AM, FM.	
2	Learn the concepts of digitization of signals viz; sampling, quantizing and encoding.	
3	Realize the basic concepts of various digital modulation techniques.	
4	Study the principles behind information theory and coding.	
5	Understand the basics of spread spectrum modulation.	

Module-1	
Prerequisites: *Modulation, Need for Modulation and types of Modulation.* **Analog Modulation:** Amplitude Modulation - AM, DSBSC, SSBSC, VSB - PSD, modulators and demodulators, Angle modulation - PM and FM - PSD, modulators and demodulators - Super heterodyne receivers. **Laboratory Sessions/ Experimental learning:** 1. Introduction to Matlab 2. Generation of AM signal using Matlab **Applications:** Broadcast transmissions, Air band radio, Quadrature amplitude modulation **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105143/ 2. https://youtu.be/00ZbuhPruJw 3. https://youtu.be/rt08yTGv_z4	**8Hrs.**
Module-2	**8Hrs.**

Pulse Modulation: Low pass sampling theorem, Quantization, PAM, Line coding, PCM, DPCM, DM, and ADPCM and ADM, Channel Vocoder, Time Division Multiplexing, Frequency Division Multiplexing. **Laboratory Sessions/ Experimental learning:** 1. Delta modulation using Matlab **Applications:** Speech recognition systems, pattern recognition systems, digital audio in computers, CDs, digital telephony, telephone and radio communications, television systems. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/ 3. https://youtu.be/s6vlXP3mYXk 4. https://youtu.be/HlGJ6xxbz8s	
Module-3	
Digital Modulation And Transmission: Phase shift keying, BPSK, DPSK, QPSK, Principles of M-ary signaling M-ary PSK & QAM, Comparison, ISI Pulse shaping, Duo binary encoding, Cosine filters, Eye pattern, equalizers. **Laboratory Sessions/ Experimental learning:** 1. Eye diagram using Matlab 2. Generation of BPSK Using LabVIEW **Applications:** LAN, CDMA, WiMAX**,** wireless communication, mobile communication, Satellite Communication, Bluetooth, RFID. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/	**8Hrs.**
Module-4	
Information Theory and Coding: Measure of information, Entropy, Source coding theorem – Shannon Fanon coding, Huffman Coding, LZ Coding, Channel capacity, Shannon-Hartley law – Shannon's limit, Error control codes, Cyclic codes, Syndrome calculation, Convolution Coding, Sequential and Viterbi decoding. **Laboratory Sessions/ Experimental learning:** 1. Huffman coding using Matlab **Applications:** Data Compression, audio/video transmission, data transmission and file transfer **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/102/108102117/ https://nptel.ac.in/courses/117/104/117104129/	**8Hrs.**

Module-5	
Spread Spectrum Multiple Access Techniques: PN sequences, properties, m-sequence, DSSS – Processing gain, Jamming, FHSS, Synchronization and tracking, Multiple Access FDMA, TDMA, CDMA. **Laboratory Sessions/ Experimental learning:** 1. Direct Sequence Spread spectrum Signal Generation & Detection using Matlab **Applications:** CDMA, Wi-Fi, WPAN, etc., **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105077/ 2. https://nptel.ac.in/courses/117/101/117101051/ 3. https://nptel.ac.in/courses/117/105/117105136/ https://youtu.be/Ojmv3I4kDn4	**8Hrs.**

Course outcomes:	
CO1	Examine the concepts of AM and FM modulation and demodulation.
CO2	Apply the concepts of sampling, quantization and encoding for digitization of signals.
CO3	Evaluate the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
CO4	Analyze source and error control coding.
CO5	Illustrate the digital communication system with spread spectrum modulation.

Text Books:	
1.	H Taub, D L Schilling, G Saha, “Principles of Communication Systems” 3/e, TMH 2007
2.	Simon Haykins, “An Introduction to Analog and Digital Communication”, John Wiley, 2003.
Reference Books:	
1.	Simon Haykin, “Digital Communication Systems”, John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.
4.	B.P.Lathi, “Modern Digital and Analog Communication systems”, 3rd edition, Oxford University Press, 2007
5.	H P Hsu, Schaum Outline Series – “Analog and Digital Communications” TMH 2006
6.	B.Sklar, “Digital Communications Fundamentals and Applications” 2/e Pearson Education 2007
7.	K Giridhar, “Information Theory And Coding”, 4th Edition, Pooja Publication, Bangalore, 2001.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Semester:VI		
Introduction To MATLAB & SIMULINK		
Course Code:	**22EA654D**	**CIE Marks: 50**
Credits:	**L:T:P: 3:0:0**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To provide a foundation in programming for engineering problem solving using the MATLAB software package.	
2	To acquaint the student with some of the terminology in this very new field and relate it to the basic engineering process of design.	
3	To provide an introduction to the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.	
4	To develop the skills to analyse and break down an engineering program and solve it algorithmically ng MATLAB	

Module-1	
Introduction to Matlab, Creating Variables, Some Useful MATLAB Functions Data Types creating simple and multiple data set in single plot, Matrix generation, Array operations and Linear equations Introduction to programming in MATLAB, Visualization and Programming ,Control flow and operators **Laboratory Sessions/ Experimental learning:** 1. Write MATLAB commands to analyze arithmetic, logical and Boolean operations. 2. Write MATLAB commands to analyze vector operations and magic matrixes. 3. Write a MATLAB program to demonstrate if and else if statement for comparing Two numbers. **Video link / Additional online information :** 1. https://in.mathworks.com/videos/writing-a-matlab-program-69023.html	**8Hrs.**
Module-2	
Solving Equations, Curve Fitting, and Numerical Techniques :Linear Algebra, Polynomials, Optimization, Differentiation/Integration, Differential Equations **Advanced Methods**: Probability and Statistics, Data Structures, Images, File I/O **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=14H4UFoxZjs	**8Hrs.**

https://www.youtube.com/watch?v=fqS873TnMDs	
Module-3	**8Hrs.**
Various functions and toolboxes: Documentation, Misc. Useful Functions, Graphical User Interfaces, Simulink, Symbolic Toolbox **Applications:** App Designing using GUI, Image processing **Video link / Additional online information:** 1. https://in.mathworks.com/matlabcentral/fileexchange/44634-design-of-graphical-user-interface-application-with-matlab https://in.mathworks.com/videos/app-designer-overview-1510748719083.html	
Module-4	**8Hrs.**
Prerequisites: *Types of filters* **Introduction to SIMULINK:** Multiple plots creating models, blocks, Systems and sub-systems, Simulating Dynamic System, Solving a model, solvers, MATLAB SIMULINK integration, S-function); MATLAB Toolboxes training (Signal Processing, Neural Network, FUZZY logic, Control System, Communication, Power System toolboxes); **Laboratory Sessions/ Experimental learning:** **1.** Create a spreadsheet file with some data (or use an existing spreadsheet with data if you have) and import the data into MATLAB. 2. Matlab 2D and 3D Plot **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=iOmqgewj5XI 2. https://in.mathworks.com/learn/tutorials/simulink-onramp.html 3. https://www.halvorsen.blog/documents/teaching/courses/matlab/matlab3.php https://www.youtube.com/watch?v=EW544PfgBrs	
Module-5	**8Hrs.**
Applications of Matlab: Diode Characteristics, Fourier Analysis, Signal Processing, Deep learning, Image processing **Laboratory Sessions/ Experimental learning:** 1. Image Enhancement Using Intensity Transformations, 2. Morphological and Other Set Operations **3.** Two-Dimensional Fast Fourier Transform **Video link / Additional online information:** 1. https://in.mathworks.com/videos/image-processing-and-computer-vision-in-matlab-and-simulink-	

96760.html https://in.mathworks.com/videos/introduction-to-deep-learning-and-applications-in-image-processing-1606855547622.html	

Course outcomes:	
CO1	Students should be able to apply computer methods for solving a wide range of engineering problems.
CO2	Students should be able to use computer engineering software to solve and present problem solutions in a technical format.
CO3	Students should be able to utilize computer skills to enhance learning and performance in other engineering and science courses.
CO4	Understand how signals, images, and data are represented and manipulated in MATLAB
CO5	Students should be able understand the various programming constructs and how they can be used to solve a computational problem.

Text Books:	
1.	Proakis & Monalakis, "Digital signal processing – Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
2.	Li Tan, Jean Jiang, "Digital Signal processing – Fundamentals and Applications", Academic Press, 2013, ISBN: 978-0-12-415893.
Reference Books:	
1.	S. Salivahanan, C. Gnanpriya, Digital Signal processing , McGraw Hill

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each).

The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO2	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO4	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO5	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**3**	**1**	**3**	**3**

High-3, Medium-2, Low-1

PROJECT PHASE – I		
Course Code:	**MVJ22ECP65**	**CIE Marks:100**
Credits:	**L:T:P: 0:0:4**	**SEE Marks: 100**
Hours:	**-**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To support independent learning.	
2	To develop interactive, communication, organization, time management, and presentation skills.	
3	To impart flexibility and adaptability.	
4	To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.	

Project Work Phase - I: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.	
Course outcomes: At the end of the course the student will be able to:	
CO1	Describe the project and be able to defend it.
CO2	Learn to use modern tools and techniques.
CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation:

Internal Marks: The Internal marks (50 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	3	2	1	1	2	1	1	2
CO2	2	2	2	3	3	2	1	1	2	1	2	2
CO3	2	2	2	3	3	2	1	1	2	1	2	2
CO4	2	2	2	3	3	2	1	1	2	1	2	2
CO5	2	2	2	3	3	2	1	1	2	1	2	2

High-3, Medium-2, Low-1

Semester: VI		
VLSI Laboratory		
Course Code:	**22EAL606**	**CIE Marks: 50**
Credits:	**L:T:P:0:0:2**	**SEE Marks: 50**
Hours:	**20**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Explore the CAD tool and understand the flow of the Full Custom IC design cycle.	
2	Learn DRC, LVS and Parasitic Extraction of the various designs.	
3	Design and simulate the various basic CMOS analog circuits and use them in higher circuits like data converters using design abstraction concepts.	
4	Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts	

PART A
ASIC Digital Design
1.Write Verilog Code for **inverter** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 2. Write Verilog Code for **buffer** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 3. Write Verilog Code for **Transmission Gate** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 4.Write Verilog Code for **Basic/universal gates** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 5. Write Verilog Code for **Flip flops -RS, D, JK, MS, T** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 6. Write Verilog Code for **Serial & Parallel adder** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation. 7. Write Verilog Code for 4-bit counter [Synchronous and Asynchronous counter] and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial

timing verification with gate level simulation.

PART B

Analog Design

1.Design an Inverter with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) DC Analysis ii) Transient Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS

Verify & Optimize for Time, Power and Area to the given constraint

2. Design the Common source amplifier with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

3. Design the Common Drain amplifier with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

4. Design a Single Stage differential amplifier, with given specifications, completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

5. Design an Operational-amp with given specification using given differential amplifier Common source and Common Drain amplifier in library and completing the design flow mentioned below:

- Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii). AC Analysis
- Draw the Layout and verify the DRC, ERC
- Check for LVS
- RC extraction

Course outcomes:

CO1	Write test bench to simulate various digital circuits.

CO2	Interpret concepts of DC Analysis, AC Analysis and Transient Analysis in analog circuits.
CO3	Design and simulate basic CMOS circuits like inverter, common source amplifier and differential amplifiers.
CO4	Design higher level circuits like operational amplifier and analog/digital converters to meet desired parameters.
CO5	Use transistors to design gates and further using gates realize shift registers and adders to meet desired parameters.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**

High-3, Medium-2, Low-1

Computer Communication Networks (Theory and Lab)		Semester	VII
Course Code	**22EA701**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3L+2P Hours/Week (L:T:P: 3:0:2)	SEE Marks	50
Total Hours of Pedagogy	40L+26P	Total Marks	100
Credits	03+02	Exam Hours	
Examination type (SEE)	Theory+ practical		

Course objectives:

- Understand the layering architecture of OSI reference model and TCP/IP protocol suite.
- Know about the protocols associated with each layer.
- Learn the different networking architectures and their representations.
- Acquire a knowledge of various routing techniques and the transport layer services.
- Learn the security features and functionality of application layer protocols.

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

Module-1

Prerequisites: Basic knowledge on computers & programming

Introduction: Data Communications: Components, Representations, Data Flow, Networks: Network criteria, Physical Structures, Network Types: LAN, WAN, Switching, Internet.

Network Models: Protocol Layering: Scenarios, Principles, Logical Connections, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI Versus TCP/IP.

Module-2

Data-Link Layer: Introduction: Nodes and Links, Services, Categories of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Data Link Layer Protocols: Simple Protocol, Stop and Wait protocol, Piggybacking.

Module-3

Network Layer: Introduction, IPV4 Addresses, Address Space, Classful Addressing, Classless Addressing, DHCP.

Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing, Unicast Routing Protocol: Internet Structure, Routing Information Protocol, Open Shortest Path First.

Module-4

Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-Back-N Protocol, Selective repeat protocol.

Transport-Layer Protocols in the Internet: User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram.

Module-5

Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client - Server Protocols: World wide web, Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Wed Based Mail, Telnet: Local versus remote logging, Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS.

Lab Experiments

1. Implement a point-to-point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.

2. Implement a four-node point to point network with links n0-n1, n1-n2 and n2-n3. Apply TCP agent between n1-n2 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.

3. Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.

4. Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.

5. Implementation of Link state routing algorithm.

Implement the following in C/C++ in Linux platform

6. Write a program for a HLDC frame to perform the following.

   i) Bit stuffing ii) Character stuffing.

7. Write a program for distance vector algorithm to find suitable path for transmission. For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases. a. Without error, b. With error

8.Implementation of Sliding Window Protocol.

9. Write a program for congestion control using leaky bucket algorithm.

Course outcome (Course Skill Set)

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

1. Analyze the layering architecture of computer networks and distinguish between the OSI reference model and TCP/IP protocol suite.
2. Apply the protocols and services of Physical and Data link layer.
3. Describe functions associated with network layer and connecting devices.
4. Analyze and apply the protocols and services of Transport layer.
5. Analyze and apply the protocols and services of application layer.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Behrouz A Forouzan," Data Communication and Networks", 3rd Ed. TMH.

2. Andrew S Tanebaum, “Computer Networks”, 4th Ed. PHI/ Pearson education.
3. S. Keshav, “An Engineering approach to Computer Networks”, 5th Ed. Pearson.
4. W.A. Shay, “Understanding communication and Networks”, Thomson.

Web links and Video Lectures (e-Resources):

- http://www.redbooks.ibm.com/abstracts/gg243376.html
- https://nptel.ac.in/courses/106/106/106106091/
- https://nptel.ac.in/courses/106/105/106105080/
- https://nptel.ac.in/content/storage2/courses/106105080/pdf/M6L2.pdf
- http://www.digimat.in/nptel/courses/video/106105183/L11.html
- https://archive.nptel.ac.in/courses/106/105/106105183/2
-

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

-

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	-	-	1	-	-	1
CO2	3	3	2	2	-	1	-	-	1	-	-	1
CO3	3	3	2	2	-	1	-	-	1	-	-	1
CO4	3	3	2	2	-	1	-	-	1	-	-	1
CO5	3	3	2	2	-	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Digital Image Processing		Semester	VII
Course Code	**22EA702**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Learn the fundamentals of digital image processing
- Understand the image transforms and other image enhancement techniques used in digital image processing.
- Study the image restoration techniques and methods used in digital image processing
- Understand region-based segmentation and segmentation using morphological watersheds. Know the color fundamentals and various morphological image processing techniques.

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

Module-1

Prerequisites: Discrete Fourier Transform, MATLAB Basics

Introduction to Digital Image Processing: What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization,

Module-2

Spatial Domain: Some Basic Relationships Between Pixels, Linear and Nonlinear Operations, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters

Frequency Domain: Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters.

Module-3

Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error(Wiener) Filtering.

Module-4

Segmentation: Point, Line, and Edge Detection: Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Advanced Technique for Edge Detection, Thresholding: Optimum Global Thresholding Using Otsu's Method, Region-Based Segmentation: Region growing, Region splitting and merging

Module-5

Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing.

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms

Course outcome (Course Skill Set)

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

1. Analyze image processing algorithms used for sampling and quantization.
2. Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
3. Implement and analyse various image restoration algorithms
4. Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
5. Conduct independent study and analyze various Morphological Image Processing 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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Rafel C Gonzalez and Richard E. Woods , "Digital Image Processing"-, PHI 3rdEdition 2010.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, —"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, 2013, ISBN: 978-81-315-1883-0
3. S.Jayaraman, S Esakkirajan, T.Veerakumar, "Digital Image Processing", Tata McGraw Hill, 2011
4. S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
5. A. K. Jain, "Fundamentals of Digital Image Processing"- Pearson 2004.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117/105/117105079/

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**

Wireless Cellular and LTE 4G Broadband		Semester	VII
Course Code	**22EA703**	50	50
Teaching Hours/Week (L: T:P: S)	4 Hours/Week (L:T:P: 4:0:0)	50	50
Total Hours of Pedagogy	50L	100	100
Credits	03	3 Hrs	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the basics of LTE standardization phases and specifications.
- Explain the system architecture of LTE and E-UTRAN, the layer of LTE, based on the use of OFDMA and SC-FDMA principles.
- Analyze the role of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer, for transferring the EPS bearer.
- Analyze the main factors affecting LTE performance including mobile speed and transmission bandwidth.

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

Module-1

Key Enablers for LTE features: OFDM, Single carrier FDMA, Single carrier FDE, Channel Dependent Multiuser Resource Scheduling, Multi antenna Techniques, IP based Flat network Architecture, LTE Network Architecture.

Wireless Fundamentals: Cellular concept, Broadband wireless channel (BWC), Fading in BWC, Modeling BWC – Empirical and Statistical models, Mitigation of Narrow band and Broadband Fading.

Module-2

Multicarrier Modulation: OFDM basics, OFDM in LTE, Timing and Frequency Synchronization, PAR, SC-FDE .

OFDMA and SC-FDMA: OFDM with FDMA,TDMA,CDMA, OFDMA, SC-FDMA, OFDMA and SC-FDMA in LTE .

Multiple Antenna Transmission and Reception: Spatial Diversity overview, Receive Diversity, Transmit Diversity, Interference cancellation and signal enhancement, Spatial Multiplexing, Choice between Diversity, Interference suppression and Spatial Multiplexing

Module-3

Overview and Channel Structure of LTE: Introduction to LTE, Channel Structure of LTE, Downlink OFDMA Radio Resource, Uplink L1, L2 146 SC-FDMA Radio Resource.

Downlink Transport Channel Processing: Overview, Downlink shared channels, Downlink Control Channels, Broadcast channels, Multicast channels, Downlink physical channels, H-ARQ on Downlink.

Module-4

Uplink Channel Transport Processing: Overview, Uplink shared channels, Uplink Control Information, Uplink Reference signals, Random Access Channels, H-ARQ on uplink.

Physical Layer Procedures: Hybrid – ARQ procedures, Channel Quality Indicator CQI feedback, Precoder for closed loop MIMO Operations, Uplink channel sounding, Buffer status Reporting in uplink, Scheduling and Resource Allocation, Cell Search, Random Access Procedures, Power Control in uplink.

Module-5

Radio Resource Management and Mobility Management: PDCP overview, MAC/RLC overview, RRC overview, Mobility Management, Inter-cell Interference Coordination

Course outcome (Course Skill Set)

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

1. Understand the system architecture and the functional standard specified in LTE 4G.
2. Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.
3. Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
4. Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 'Fundamentals of LTE', Prentice Hall, Communications Engg. and Emerging Technologies.
2. LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.
3. 'EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G UMTS' by Pierre Lescuyer and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.
4. 'LTE – The UMTS Long Term Evolution ; From Theory to Practice' by Stefania Sesia, Issam Toufik, and Matthew Baker, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/117/102/117102062/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

Professional Elective Course:

WIRELESS SENSOR NETWORKS (Theory)		Semester	VII
Course Code	**22EA714A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- To provide a basic understanding of the important aspects of Wireless sensor networks
- To provide a basic understanding of wireless sensor and transmission technology
- Understand about middleware, performance and traffic management.
- Understand communication protocols to be used for wireless sensor networks
- Apply the applications of WSN in various fields

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

Module-1

Wireless Sensor Networks: Introduction, applications of sensor networks, basic overview of the technology, basic sensor network architectural elements, present day sensor network research, challenges and hurdles, examples of Category 2 WSN applications, examples of Category 1 WSN applications.

Module-2

Wireless sensor technology: Introduction, sensor node technology – overview, hardware and software, sensor taxonomy, WN operating environment, WN trends.

Wireless Transmission technology and systems: Introduction, Campus applications, MAN/WAN applications.

Module-3

Middleware for WSNs: Introduction, principles, architecture, data related functions Performance and traffic management: background, WSN Design issues, performance modelling of WSNs.

Module-4

Communication Protocols: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based

protocols (LEACH) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering.

Module-5

APPLICATIONS OF WSN

WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications

Course outcome (Course Skill Set)

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

1. Discuss the overview of the Wireless sensor networks characteristics and applications
2. Present the sensor, transmission technology and systems associated with WSN.
3. Understand the concepts of middleware, performance evaluation and traffic management in WSN.
4. Apply the knowledge to identify appropriate physical and MAC layer protocol
5. Understand the applications of WSN in various fields

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. 'Wireless Sensor Networks', Kazem Sohraby, Daniel Minoli and Taieb Znati, Wiley, 2015.
2. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106/105/106105166/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	-	-	1	-	-	1
CO2	3	3	2	2	-	1	-	-	1	-	-	1
CO3	3	3	2	2	-	1	-	-	1	-	-	1
CO4	3	3	2	2	-	1	-	-	1	-	-	1
CO5	3	3	2	2	-	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

5G FUNDAMENTAL'S AND ARCHITECTURE (Theory)		Semester	VII
Course Code	**22EA714B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the essential principles of 5G communications
- Describe the 5G architecture and 5G Internet.
- Analyze the cognitive radio networks for 5G.
- Analyze the 5G spectrum crunch and security issues.

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

Module-1

History of 5G: Historical background, 5G use cases, and system concept: Use case requirements, 5G system concept.

The 5G Architecture: Introduction, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Physical architecture and 5G deployment

Module-2

Machine-type communications: Introduction, Fundamental techniques for MTC, Massive MTC, Massive MTC, Summary of uMTC features.

Device to Device (D2D) communications: From 4G to 5G, Radio resource management for mobile broadband D2D, Multi-hop D2D communications for proximity and emergency services, Multi operator D2D communication

Module-3

The 5G radio-access technologies: Access design principles for multi-user communications, Multi-carrier with filtering: a new waveform, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.

Module-4

Relaying and wireless network coding: The role of relaying and network coding in 5G wireless networks, Multi-flow wireless backhauling, Highly flexible multi-flow relaying,Buffer-aided relaying.

Module-5
Mobility management in 5G, Dynamic network reconfiguration in 5G **Spectrum:** Introduction, 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies, Value of spectrum for 5G: a techno-economic perspective .
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Describe the concepts of 5G networks and its architecture. 2. Analyze the spectrum optimization using cognitive radio in 5G network. 3. Analyze the white space spectrum opportunities and challenges. 4. Analyze the security issues and challenges in 5G communication systems. 5. Describe the concepts of 5G networks and its architecture.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. 5G Mobile and Wireless Communication Technology, AfifOsseran, Jose F Monserrat, Patrick Marsch, Cambridge University Press, 2016.
2. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, John Wiley & Sons 2015, ISBN: 9781118867525.
3. 5G Core Networks Powering Digitization, Stephen Rommer, Academic Press,2019 ISBN: 978-0-08-1030009-7.

Web links and Video Lectures (e-Resources):

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

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

ROBOTICS & AUTOMATION		Semester	
Course Code	**22EA714C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Study the history, concept development and key components of robotics technologies.
- Know the concept of interfacing actuators and other components
- Understand basic mathematics manipulations of spatial coordinate representation and transformation.
- Learn basic robot forward and inverse kinematic problems
- Analyze basic robotic dynamics, path planning and control problems

Teaching-Learning Process (General Instructions)

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

Module-1

Basic concepts in robotics: Definition, anatomy of robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics, Industrial Applications of Robots. Drives for robots: Electric, hydraulic and pneumatic. Sensors: Sensor Characteristics, Sensor utilization, Position Sensor, Velocity Sensor, Acceleration Sensor.

Module-2

Robot drivers, Sensors and Vision: Introduction to techniques, Image acquisition and processing, Different types of grippers- Mechanical, Magnetics, vacuum, Adhesive, Gripper force Analysis and Gripper Design, overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.

Module-3

Robot Kinematics and Dynamics: Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Link inertia tensor and manipulator inertia tensor, Newton –Eller formulation for RP and RP manipulators.

Module-4

Robot Kinematics: Dynamics and Programming methods, Robot language classification, Robot language structure, Kinematics and Path Planning: Solution of inverse kinematics problem, multiple solution Jacobian work envelop, hill climbing techniques, robot programming languages elements and its functions. Simple programs on Sensing distance and direction.

Module-5

Design and Applications: Developing and building a robot, Models of flexible links and joints, Robotic arm – Components and structure, Types of joints and workspace, Design models for mechanic arms and lifting systems, robots in manufacturing and non- manufacturing applications, robot cell design.

Course outcome (Course Skill Set)

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

6. Analyze the concept development and key components of robotics technologies
7. Select the components for interfacing actuators
8. Implement basic mathematics manipulations of spatial coordinate representation and Transformation.
9. Solve basic robot forward and inverse kinematic problems
10. Design robots which are capable to solve basic robotic dynamics, path planning and control problems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

Text Books:

1. "Introduction to Robotics", By S.K.Saha , Tata McGraw Hill
2. "Robotics Control, Sensing ,Vision and Intelligence" by K.S. Fu, R.C .Gonzalez, C.S.G.Lee , Tata McGraw HillJ. Hirchhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.

Reference Books:

1. Robert J. Schilling, “Fundamentals of Robotics- Analysis and Control”, Prentics Hall india.
2. “Robotics Technology and Flexible Automation” by S.R.Deb, S. Deb, Tata McGraw Hill
3. “Robot Motion and Control (Recent Developments)” by M.Thoma& M. Morari

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112105249

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

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	-	1
CO2	3	3	3	2	1	1	-	-	1	-	-	1
CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Soft Computing Techniques		Semester	VII
Course Code	**22EA714D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Learn soft computing techniques and their applications.
- To introduce the concepts of fuzzy sets and fuzzy logic.
- To make students familiar with neural networks.
- Analyze various neural network architectures.
- Apply soft computing techniques to solve problems.

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

Module-1

Introduction to Soft Computing – Neural networks, Fuzzy logic, Gnetic algorithms, Hybrid systems and its applications, Fundamental concept of ANN, Evolution basic Model of ANN, Terminologies used in ANN, MP model, Hebb model.

Module-2

Perception Network: Adaptive linear neuron, Multiple adaptive linear neurons, Back propagation Network (Theory, Architecture for training, learning factors, testing and applications of all the above NN models).

Module-3

Introduction to Classical sets and Fuzzy sets: Classical relations and fuzzy relations, Membership functions – Fuzzy rules and Fuzzy Reasoning, Fuzzy Interference Systems, Fuzzy Expert Systems, Fuzzy Decision Making

Module-4

Defuzzification: Fuzzy decision making and applications.

Module-5

Genetic Algorithms: Introduction, Basic operations, Traditional algorithms, Simple GA General genetic algorithms, The Schema theorem, Genetic programming, applications.

Course outcome (Course Skill Set)

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

1. Implement machine learning through neural networks
2. Understand Artificial neural networks and its applications
3. Develop a Fuzzy expert system
4. Model Neuro Fuzzy system for clustering and classification
5. Design Genetic Algorithm to solve the optimization problem

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. S.N.Sivanandam & S.N.Deepa "Principles of Soft Computing" Wiley India Pvt. Ltd., 2007 B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.

2. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI,2004, Pearson Education 2004.
3. N. K. Sinha and M. M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications- Academic Press /Elsevier. 2009
4. R. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier, 200

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106/105/106105173/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	--	--	--	--	--	--	1
CO2	3	3	3	3	2	--	--	--	--	--	--	2
CO3	3	2	2	2	2	--	--	--	--	--	--	2
CO4	3	2	2	2	1	--	--	--	--	--	--	2
CO5	3	2	2	2	2	--	--	--	--	--	--	2

Open Elective Course

Medical Electronics		Semester	VII
Course Code	**22EA755A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Explain physiological parameters such as electrical, non-electrical and the recording methods.
- Learn the methods used for recording and measuring the biological signals.
- Illustrate the various Medical Imaging devices used in the hospitals.
- Explain the telemetry systems and know the safety aspects required in medical equipment.
- Understand the various Therapeutic Devices and know about recent trends in medical system.

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

Module-1

Prerequisites: Basics of Transducer

Fundamentals of Physiology and Transducer:

Types of Bioelectric Potentials: Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials.

Biological Systems: Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems

Electrodes and Transducers in Medical systems: Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes.

Module-2

Electrical and Non-Electrical Parameter Measurement:

Electro Physiological Measurement: Biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics

Non Electrical Parameter Measurement: Measurement of blood pressure, Ultra sound blood flow meter, Blood flow cardiac output, Heart rate, heart sound, measurement of gas volume, flow rate of CO2 and O2 in exhaust air, pH of blood

Module-3

Amplifiers used in Medical Electronics: Amplifiers, preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier

Medical Imaging: X-ray machine, Computer tomography, Magnetic resonance imaging system, Positron emission tomography and endoscopy.

Module-4

Telemetry: Introduction to telemetry systems, Different types of biotelemetry systems, Retinal Imaging, Imaging application in Biometric systems.

Safety in Medical Environment: Electrical safety in medical environment, shock hazards, leakage current, Instruments for checking safety parameters of biomedical equipment

Module-5

Assisting and Therapeutic Devices: Cardiac pacemakers, Defibrillators, Ventilators, Surgical diathermy, Heart lung machine, Laser in surgery and medicine.

Recent Trends in medical System: Insulin Pumps, Radio pill, Endo microscopy, Brain machine interface, Lab on a chip, ICCU patient monitoring system, Wearable Antennas.

Robotic Devices: Nano Robots, Robotic surgery, Orthopedic prostheses fixation.

Course outcome (Course Skill Set)

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

1. Analyse the operation and characteristics of Electronic devices and use of them in applications.
2. Evaluate the performance of electronic circuits.
3. Demonstrate the electronic systems and analyse their applicability
4. Analyse requirement of electronic devices and systems.
5. Design a simple prototype for a certain application.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. R.S. Khandpur, "Hand book of Bio Medical Instrumentation" (2nd edition)- ISBN-13: 9789339205430.
2. Mandeep Singh, "Introduction to Biomedical Instrumentation", ISBN-13: 9788120350226
3. S.K. Guha, "Principles of Medical Electronics and biomedical Instrumentation" - ISBN-13: 978-8173712579.
4. J.G.Webster(Wiley India), "Medical instrumentation Application and Design", ISBN-13: 978-0471676003.
5. Joseph D. Bronzino, "The Biomedical Engineering Handbook", Third Edition, CRC Press-2006.
6. John D. Enderle and Joseph D. Bronzino, "Introduction to Biomedical Engineering", Third Edition, Elsevier Inc.-2012.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/102/104/102104043/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	-	-	1	-	-	1
CO2	3	3	2	2	2	1	-	-	1	-	-	1
CO3	3	3	2	2	3	1	-	-	1	-	-	1
CO4	3	3	2	2	3	1	-	-	1	-	-	2
CO5	3	3	2	2	2	1	-	-	1	-	-	3

IoT and Wireless Sensor Networks		Semester	VII
Course Code	**22EA755B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Provide knowledge about IoT and M2M architecture.
- Understand various layers of IoT and their functionality.
- Describe Cloud computing and design principles of IoT
- Understand the architecture and design principles of WSNs.
- Provide knowledge about MAC and routing protocols in WSN

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

Module-1

Prerequisites: *Knowledge on Computer Networks*

Introduction to IoT: Genesis, Digitization, Impact- Connected Roadways, Buildings, IoT Challenges, Network Architecture and Design, Drivers Behind New Network Architectures, Security, Constrained Devices and Networks Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture.

Module-2

IoT Layers and functionality : IoT Network Architecture and Design Core IoT Functional Stack, Layer1(Sensors and Actuators) , Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management. Layer 3(Applications and Analytics), Analytics vs Control, Data vs Network Analytics IoT Data Management and Compute Stack.

Module-3

Data Collection, Storage and Computing using a Cloud Platform: Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud - based data collection, storage and computing services using Nimbits, The Hierarchy of Edge, Fog, and Cloud.

Prototyping and Designing Software for IoT Applications: Introduction, Prototyping Embedded device software, Programming Embedded Device, Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development.

Module-4
Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Architectures: Single-Node Architecture, Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture, Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts.
Module-5
Communication Protocols: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based protocols (LEACH) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Analyze different IOT Architecture and select them for a particular application. 2. Evaluate the sensor data generated and map it to IOT protocol stack. 3. Implement and execute programs using development tools 4. Develop an energy efficient system for WSN. 5. Create a real life application involving Wireless Sensor Networks using IoT concepts.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743
2. Raj Kamal,"Internet of Things-Architecture and design principles", McGraw Hill Education.
3. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor NetworksTechnology, Protocols, And Applications", John Wiley, 2007.
5. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.

6. Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106/105/106105166/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	-	-	2	-	-	1
CO2	3	3	3	2	2	2	-	-	2	-	-	1
CO3	3	3	3	3	2	2	-	-	2	-	-	1
CO4	3	3	3	3	2	2	-	-	2	-	-	1
CO5	3	3	3	3	2	2	-	-	2	-	-	1

Sensor Technology		Semester	VII
Course Code	**22EA755C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand various technologies associated in manufacturing of sensors
- Provide better familiarity with different sensors and their applications in real life.
- Acquire knowledge about types of sensors used in modern digital systems.
- Evaluate the technological and physical limitations of a specific sensor.
- Propose a suitable sensor for a given measurement situation.

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

Module-1

Prerequisite: *Basic Electronics, Knowledge on physical quantities*

Sensors Fundamentals and Characteristics: General Concepts and Terminology, Sensor Classification, Static Characteristics, Dynamic Characteristics, Materials for Sensors, Microsensor Technology.

Module-2

Primary sensors: Temperature sensors, Pressure sensors, Flow-velocity and flow-rate sensors, Level sensors, Force and torque sensors, Acceleration and inclination sensors and Velocity sensors.

Resistive Sensors: Resistive Temperature Detectors (RTDs),Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas sensors.

Module-3

Reactance Variation and Electromagnetic Sensors: Capacitive sensors: Variable capacitor and Differential capacitor**,** Inductive sensors:Variable reluctance sensors, Eddy current sensors, Linear Variable Differential Transformers (LVDTs), Electromagnetic sensors: Sensors based on Faraday's Law and Hall effect sensors.

Module-4

Self-Generating sensors: Thermoelectric sensors, Piezoelectric sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors, Proximity sensors.

Module-5
Digital sensors: Position encoders,Resonant sensors: SAW sensors, Vibrating wire strain gages, Vibrating cylinder sensors, Digital flow meters **Other sensing methods:** Charge-Coupled sensors – Fundamentals & types of CCD, Fiber-Optic sensors, Ultrasonic-based sensors, Gyroscope sensors, optical sensors, IR sensors.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Understand the concept of sensors and its characteristics. 2. Explain the working principles of primary and resistive sensors. 3. Understand the inductive, capacitive and Electromagnetic sensors and its applications 4. Identify alternative methods to measure common quantities such as temperature, pressure, force and acceleration. 5. Select appropriate sensors used for various applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Ramon Pallas & John G.Webster, "Sensors and signal conditioning", John Wiley & Sons., 2nd Ed.,2001.
2. J. Fraden, "Handbook of Modern Sensors: Physical, Designs, and Applications", AIP Press, Springer, 3rd Ed.,2004.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108/105/108105064/
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**2**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**1**
CO2	**3**	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**1**
CO3	**3**	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**1**
CO4	**3**	**2**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**1**
CO5	**3**	**2**	**2**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**

Internet of Things		Semester	VII
Course Code	**22EA755D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3 Hours/Week (L:T:P: 3:0:0)	SEE Marks	50
Total Hours of Pedagogy	40L	Total Marks	100
Credits	03	Exam Hours	3 Hrs
Examination type (SEE)	Theory		

Course objectives:

- To understand the various modes of communications with Internet.
- To learn the basic issues, policy, and challenges on the Internet
- To get an idea of some of the application areas where Internet of Things can be applied.
- To understand the cloud and internet environment

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

Module-1

Prerequisites : Basic Knowledge about C or C++

Introduction to IoT: Definition – Foundations – Challenges and Issues - Identification - Security. Components in internet of things: Control Units – Sensors – Communication modules –Power Sources – Communication Technologies – RFID – Bluetooth – Zigbee – Wifi – Rflinks –Mobile Internet – Wired Communication-IoT Platform Overview-Raspberry pi-Arduino boards. *

Module-2

IoT Protocols: Protocol Standardization for IoT-M2M and WSN Protocols-SCADA and RFID Protocols-Issues with IoT Standardization-Protocols-IEEE 802.15.4-BACNet Protocol-Zigbee Architecture - Network layer – APS Layer – Security. *

Module-3

Resource Management in the Internet of Things: Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things Architecture - The Role of Context - Design Guidelines - Software Agents for Object – Data Synchronization- Types of Network Architectures - Fundamental Concepts of Agility and Autonomy-Enabling Autonomy and Agility by the Internet of Things - The Evolution from the RFID-based EPC Network to an Agent based Internet of Things- Agents for the Behaviour of Objects.*

Module-4

Case Study and IoT Application Development: IoT applications in home- infrastructures security- Industries- IoT electronic equipment's. Use of Big Data and Visualization in IoT Industry 4.0 concepts - Sensors and sensor Node –Interfacing using Raspberry Pi/Arduino- Web Enabled Constrained Devices. *

Module-5

Web of Things: Web of Things versus Internet of Things-Architecture Standardization for WoT-Platform Middleware for WoT- WoT Portals and Business Intelligence-Cloud of Things: Grid/SOA and Cloud Computing-Cloud Standards –Cloud of Things Architecture-Open Source e-Health sensor platform.

Course outcome (Course Skill Set)

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

1. Identify the components of IoT.
2. Analyse various protocols of IoT.
3. Design portable IoT using appropriate boards
4. Develop schemes for the applications of IOT in real time scenarios.
5. Design business Intelligence and Information Security for WoT

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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:

Books

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective" -CRC Press-2012.
2. Dieter Uckelmann, Mark Harrison, "Architecting the Internet of Things", Springer2011.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things (A Hands-On-Approach)", VPT, 2014.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.
5. Luigi Atzori, Antonio Lera, Giacomo Morabito, "The Internet of Things: A Survey", Journal on Networks, Elsevier Publications, October 2010.

Web links and Video Lectures (e-Resources):

- http://www.theinternetofthings.eu/what-is-the-internet-of-things.

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

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO2	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO3	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**
CO4	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**2**	**-**	**3**
CO5	**3**	**3**	**3**	**3**	**-**	**-**	**2**	**2**	**3**	**2**	**-**	**3**

PROJECT PHASE – II		Semester	VII
Course Code	**22EAP76**	CIE Marks	100
Teaching Hours/Week (L: T:P: S)		SEE Marks	100
Total Hours of Pedagogy	--	Total Marks	
Credits	--	Exam Hours	3 Hrs
Examination type (SEE)			

Course objectives:

- To support independent learning.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.
- To inspire independent and team working.

Teaching-Learning Process (General Instructions)

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

Project Work Phase - II

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

Course outcome (Course Skill Set)

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

1. Describe the project and be able to defend it. Develop critical thinking and problem solving skills.
2. Learn to use modern tools and techniques. Communicate effectively and to present ideas clearly and coherently both in written and oral forms.
3. Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
4. Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
5. Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

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). The student is declared as a pass in the course if he/she 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:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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).**

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

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

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	3	2	1	1	2	1	1	2
CO2	2	2	2	3	3	2	1	1	2	1	2	2
CO3	2	2	2	3	3	2	1	1	2	1	2	2
CO4	2	2	2	3	3	2	1	1	2	1	2	2
CO5	2	2	2	3	3	2	1	1	2	1	2	2