Microwave Engineering and Antenna Theory		Semester	7
Course Code	**BEC701**	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	3 Hours
Examination nature (SEE)	Theory		

Course objectives:

This course will enable students to:

1. Describe the microwave properties and its transmission media.
2. Describe the microwave devices for several applications.
3. Understand the basic concepts of antenna theory.
4. Identify antenna types for specific applications.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
3. Adopt Problem Based Learning (PBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize & analyze information rather than simply recall it.
4. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
5. Using videos for demonstration of the fundamental principles to students for better understanding of concepts.
6. Demonstration of microwave devices and Antennas in the lab environment where students can study them in real time.

MODULE-1

Microwave Sources: Introduction, Gunn Diode (Text 2: 7.1,7.1.1,7.1.2)

Microwave transmission lines: Microwave frequencies, Microwave devices, Microwave systems. Transmission line equations and solutions, Reflection Coefficient and Transmission Coefficient. Standing wave and standing wave ratio. Smith chart, Single stub matching.

Text 2: 0.1, 0.2, 0.3, 3.1, 3.2, 3.3, 3.5, 3.6 (except double stub matching)

Teaching-Learning Process	Chalk and Talk would be helpful for the quantitative analysis. Videos of the Basic principles of the devices would help students to grasp better. **RBT Level**: L1, L2, L3

MODULE-2

Microwave Network Theory: Introduction, S matrix representation of multi-port networks (Text 1: 6.1, 6.3, 6.3.1, 6.3.2)

Microwave passive devices: Coaxial connectors and Adapters, Attenuators, Phase shifters, waveguide Tees, Magic Tee, Circulator, Isolator. (Text 1: 6.4.2, 6.4.14, 6.4.15, 6.4.16, 6.4.17 A, B)

Teaching-Learning	Chalk and Talk, PowerPoint Presentation
MODULE-3	
Strip Lines: Introduction, Microstrip lines, Parallel Strip lines (Text 2: 11.1,11.2) **Antenna Basics**: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam efficiency, Directivity and Gain, Antenna Aperture Effective height, Bandwidth, Radio communication Link, Antenna Field Zones (Text 3: 2.1-2.7, 2.9-2.11, 2.13).	
Teaching-Learning Process	Chalk and talk method, Power point presentation and videos. RBT Level: L1, L2, L3
MODULE-4	
Point sources and arrays: Introduction, Point Sources, Power patterns, Power theorem, Radiation Intensity, Arrays of 2 isotropic point sources, Pattern multiplication, Linear arrays of n Isotropic sources of equal amplitude and Spacing. (Text 3: 5.1-5.6, 5.9, 5.13) **Electric Dipole**: Introduction, Short Electric dipole, Fields of a short dipole. Radiation resistance of a short dipole. Thin linear antenna (field analysis). (Text 3: 6.1-6.5)	
Teaching-Learning Process	Chalk and talk method, Power point presentation and videos. RBT Level: L1, L2, L3
MODULE-5	
Loop and Horn antenna: Introduction: Small loop, Comparison of far fields of small loop and short dipole. Radiation resistance of small loop, Horn Antennas, Rectangular antennas. (Text 3: 7.1,7.2, 7.4, 7.6, 7.7, 7.8, 7.19, 7.20) **Antenna Types**: Yagi Uda array, Parabolic Reflector, Microstrip Antennas, Features of Microstrip Antennas, (Text 3: 8.8, 9.5, 14.1,14.2)	
Teaching-Learning Process	Chalk and talk method, Power point presentation and videos. RBT Level: L1, L2, L3

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Measurement of frequency, guide wavelength, power and attenuation in a microwave Test bench.
2	Measurement of VSWR and reflection coefficient and attenuation in a microwave test bench setup
3	To measure unknown impedance using Smith chart through test bench setup.
4	Study of characteristics of E plane Tee / H plane Tee.
5	Study of characteristics of Magic Tee.
6	Determination of resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate.
7	Coupling and Isolation characteristics of microstrip directional coupler.
8	Determination of power division of microstrip power divider.
9	To plot a 2D and 3D radiation pattern of dipole Antenna (Use any simulation software)
10	Obtain the radiation pattern of a Yagi-Uda Antenna array and calculate its directivity.

Course outcomes (Course Skill Set):

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

1. Describe the use and advantages of microwave transmission
2. Analyze various parameters related to transmission lines.
3. Identify microwave devices for several applications.
4. Analyze various antenna parameters and their significance in building the RF system.
5. Identify various antenna configurations for suitable 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 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.

Text Books:

1. Microwave Engineering -Annapurna Das, Sisir K Das, TMH Publication, 2ndEdition, 2010.
2. Microwave Devices and Circuits – Samuel Y Liao, Pearson Education.
3. Antennas and Wave Propagation -John D Krauss, Ronald J Marhefka, Ahmad S Khan, 4th Edition, McGraw Hill Education, 2013.

Reference Books:

1. Microwave Engineering -David M Pozar, John Wiley India Pvt Ltd., Pvt Ltd., 3rd edition, 2008.
2. Microwave Engineering-Sushrut Das, Oxford Higher Education, 2nd Edn, 2015.
3. Antennas and Wave Propagation- Harish and Sachidananda, Oxford University Press, 2007.

Web links and Video Lectures (e-Resources):

1. https://www.tutorialspoint.com/antenna_theory/antenna_theory_horn.html
2. http://www.antenna-theory.com/antennas/smallLoop.php

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

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

COMPUTER NETWORKS & PROTOCOLS
B.E., VII Semester, Electronics & Communication Engineering [As per Choice Based Credit System (CBCS) Scheme]

Course Code	BEC702	CIE Marks	50
Teaching Hours/Week (L: T: P: S)	(3:0:2:0)	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives: This course will enable students to:

*Understand the layering architecture of OSI reference model and TCP/IP protocolsuite.

*Understand the protocols associated with each layer.
*Learn the different networking architectures and their representations.
* Learn the various routing techniques and the transport layer services.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction: Data communication: Components, Data representation, Data flow, Networks: Network criteria, Physical Structures, Network types: LAN, WAN, Switching, The Internet.. Network Models: 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. Data-Link Layer: Introduction: Nodes and Links, Services, Two Categories' of link, Sublayers, Link Layer addressing: Types of addresses, ARP(1.1,1.2, 1.3.1to 1.3.4,2.2, 2.3 ,9.1, 9.2.1, 9.2.2)

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

Module-2

Data Link Control (DLC) services: Framing, Flow and Error Control. Media Access Control: Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. Connecting Devices: Hubs, Switches, Virtual LANs: Membership, Configuration, Communication between Switches, Advantages. Wired and Wireless LANs: Ethernet Protocol, Standard Ethernet. Introduction to wireless LAN: Architectural Comparison, Characteristics, Access Control. (11.1,12.1,13.1, 13.2.1 to 13.2.5,15.1,17.1,17.2)

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

Module-3

Network Layer: Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing, DHCP, Network Address Resolution Network Layer Protocols: Internet Protocol (IP): Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams. IPv6 addressing and Protocol. Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing. (18.1(excluding 18.1.3), 18.2, 18.4,19.1,20.1, 20.2,22.1 and 22.2)

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

Module-4

Transport Layer: Introduction: Transport Layer Services, Connectionless and Connection oriented Protocols, Transport Layer Protocols: Simple protocol, Stop and wait protocol, Go-BackN Protocol, Selective repeat protocol, Piggybacking 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, Windows in TCP, Error control, TCP congestion control. (23.1, 23.2.1, 23.2.2, 23.2.3, 23.2.4, 23.2.5,24.2, 24.3.1, 24.3.2, 24.3.3, 24.3.4, 24.3.6, 24.3.8, 24.3.9)

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

Module-5

Application Layer: Introduction: providing services, Application- layer paradigms, Standard Client Server Protocols: Hyper Text Transfer Protocol, FTP: Two connections, Control Connection, Data Connection, Electronic Mail: Architecture, Domain Name system: Name space, DNS in internet, Resolution, DNS Messages, Registrars, DDNS, security of DNS. Quality of Service (25.1, 26.1.2, 26.2, 26.3, 26.6, 30.1, 30.2.)

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

PRACTICAL COMPONENT OF IPCC

Using suitable simulation software, demonstrate the operation of the following :

Sl.No	Simulation experiments using NS2/ NS3/ OPNET/ NCTUNS/ NetSim/ QualNet or any other equivalent tool
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-n2, n1-n2 and n2-n3.Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine thenumber 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 Ethernet LAN using n nodes and assign multiple traffic to the nodes andobtain congestion window for different sources/ destinations.
5	Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.
6	Implementation of Link state routing algorithm
Implement the following using programming languages C/C++ etc,.	
7	Write a program for a HLDC frame to perform the following. i) Bit stuffing ii) Character stuffing.
8	Write a program for distance vector algorithm to find suitable path for transmission
9	Implement Dijkstra‘s algorithm to compute the shortest routing path.
10	For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify theprogram for the cases : i)with out error ii)with error
11	Implementation of Stop and Wait Protocol and Sliding Window Protocol
12	Write a program for congestion control using leaky bucket algorithm.

Course Outcomes

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

1. Understand the concepts of networking thoroughly.
2. Identify the protocols and services of different layers.
3. Distinguish the basic network configurations and standards associated with each network.
4. Discuss and analyze the various applications that can be implemented on networks.

Assessment Details (both CIE and SEE)

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

CIE for the theory component of IPCC

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

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

Two assignments each of **10 Marks**

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

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

CIE for the practical component of IPCC

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

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

SEE for IPCC

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

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

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

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

The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured out of 100 will be scaled down to 50 marks.

Suggested Learning Resources:

Text Book:

Data Communications and Networking, Forouzan, 5th Edition, McGraw Hill, 2016 ISBN: 1-25-906475-3

Reference Books:

1.A.S Tanenbaum - Computer Networks, 4th Edition, PHI, 2003
2.Computer Networks, James J Kurose, Keith W Ross, Pearson Education,2013, ISBN: 0-273-76896-4
3.Introduction to Data Communication and Networking, Wayarles Tomasi, Pearson Education, 2007, ISBN:0130138282

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

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

Wireless Communication Systems		Semester	5
Course Code	BEC703	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	50 Hours	Total Marks	100
Credits	04	Exam Hours	3 Hours
Examination type (SEE)	**Theory**		

Course objectives:

- Understand the concepts of signal propagation over wireless channels
- Understand the multiple access techniques used in cellular communications standards.
- Understand the system architecture and layers of LTE based on the use of OFDMA and SC-FDMA principles.
- Understand the design and coding of MIMO wireless systems .

Teaching-Learning Process (General Instructions)

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

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

Module-1

Principles of Wireless Communications: The Wireless Communication Environment, Modelling of wireless systems, System model for narrowband Signals, Rayleigh fading Wireless Channel.

The Wireless Channel: Basics of Wireless Channel Modelling, Average Delay Spread in Outdoor Cellular Channels, Coherence bandwidth, Relation between ISI and Coherence Bandwidth, Doppler fading, Doppler Impact on a wireless Channel, Coherence Time.

[**Text1:** 3.1 to 3.4, 4.1 to 4.7]

Module-2

Code Division for Multiple Access (CDMA): Basic CDMA Mechanism, Fundamentals of CDMA codes, Spreading Codes based on PN sequences, Correlation Properties of Random CDMA Spreading Sequences, Advantages of CDMA.

Orthogonal Frequency Division Multiplexing (OFDM): Introduction, Motivation and Multicarrier basics, OFDM basics, OFDM Example, MIMO OFDM, OFDM Peak to Average Power ratio, SC-FDMA.

[**Text1:** 5.1 to 5.5, 5.7, 7.1, 7.2, 7.3, 7.5, 7.7, 7.8]

Module-3

Evolution of Cellular Technologies: First Generation Cellular Systems, 2G Digital cellular systems – GSM and its Evolution, 3G Broadband Wireless Systems, Key Enabling Technologies and features of LTE, LTE Network Architecture.

Frequency Domain Multiple Accesses: Multiple Access for OFDM Systems, Orthogonal Frequency Division Multiple Access, Single Carrier Frequency Division Multiple Access.

[Text2: 1.2.1, 1.2.1.1, 1.2.2, 1.2.2.1, 1.2.3 (Only the mentioned sections and subsections), 1.4, 1.5, 4.1, 4.2, 4.3]

Module-4

Multiple Input Multiple Output Wireless Communications: Introduction to MIMO Communications, MIMO system Model, MIMO Zero Forcing Receiver, MIMO MMSE Receiver, Singular Value decomposition of MIMO Channel, SVD and MIMO capacity, Alamouti and Space-Time Codes, Nonlinear MIMO receiver: V-Blast, MIMO Beamforming.
[Text1:6.1,6.2, 6.3, 6.4, 6.5, 6.6, 6.8, 6.9, 6.10]

Module-5

Overview and Channel Structure of LTE: Radio Interface Architecture, LTE Design principles, Network Architecture, Radio Interface Protocols, Hierarchical Structure of LTE: Logical Channels, transport Channels and Physical Channels, Channel mapping, Downlink OFDMA Radio resources, Physical Resource Blocks for OFDMA, Uplink SC-FDMA Radio resources.
[**Text2:** 6.1 to 6.4]

Course outcome (Course Skill Set)

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

1. Describe the wireless channel models for slow and fast fading environment.
2. Understand the different multiple access technologies used in wireless communications.
3. Understand the system architecture and the functional standard specified in LTE 4G.
4. Describe the of MIMO transmitter and receiver process using coding examples.

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 22OB4.2, 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:

Text Book

1. Aditya K Jagannatham, "Principles of Modern Wireless Communication systems, Theory and Practice ", Mc Graw Hill Education (India) Private Limited, 2017, ISBN 978-81- 265-4231-4.
2. Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed, "Fundamentals of LTE", Pearson India Education Services Private Limited, 2018, ISBN: 978-93-530-6239-2.

Reference Books

1. T L Singal, "Wireless Communications", Mc Graw Hill Education (India) Private Limited, 2016, ISBN:978-0-07-068178-1
2. Theodore Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 2002, ISBN 0-13-042232-0.

3. Gary Mullet, Introduction to Wireless Telecommunications Systems and Networks, First Edition, Cengage Learning India Pvt Ltd., 2006, ISBN - 13: 978-81-315-0559-5.

Web links and Video Lectures (e-Resources):

1. **Advanced 3G and 4G wireless Mobile Communications:**

   https://nptel.ac.in/courses/117104099

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

1. Experiential Learning by using free and open source software's OCTAVE or Python

Application Specific Integrated Circuit			
Course Code	**BEC714A**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03(Theory)

Course Learning objectives: This course will enable students to:

- Understand the ASIC design methodologies and programmable logic cells to implement a function on IC.
- Analyze the back-end physical design flow, including partitioning, floor-planning, placement, and routing.
- Understand performance evaluation parameters in FPGA and ASIC VLSI chip designs.

Module-1

Introduction to ASICs: Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries. **CMOS Logic:** Data path Logic Cells: Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells, Cell Compilers.

Text 1: [1.1,1.2,1.5,2.6,2.7,2.8]

RBT Levels: L2

Module-2

ASIC Library Design: Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi-stage cells, Optimum delay and number of stages, library cell design.
Programmable ASIC Logic Cells: MUX as Boolean function generators, Acted ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA:XC3000 CLB, Altera FLEX and MAX, Programmable ASIC I/O Cells: Xilinx and Altera I/O Block

Text 1: [3.3,3.4,5.1,5.2,5.3,5.4]

RBT Levels: L2, L3

Module-3

Low-level design entry: Schematic entry: Hierarchical design, The cell library, Names, Schematic Icons & Symbols, Nets, Schematic Entry for ASICs, Connections, vectored instances & buses, Edit in place, attributes, Netlist screener.
ASIC Construction: Physical Design, CAD Tools System partitioning, Estimating ASIC size. Partitioning: Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement, KL, FM and Look Ahead algorithms.

Text 1: [9.1,15.2, 15.3, 15.4,15.7]

RBT Levels: L2, L3

Module-4

Floor planning and placement: Goals and objectives, Measurement of delay in Floor planning, Floor planning tools, Channel definition, I/O and Power planning and Clock planning.
Placement: Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Time driven placement methods, Physical Design Flow.

Text 1: [16.1,16.2,16.3]

RBT Levels: L2, L3

Module-5

Routing: Global Routing - Goals and objectives, Global Routing Methods, Global routing between blocks, Back-annotation. Detailed Routing - Goals and objectives, Measurement of Channel Density, Left-Edge Algorithm, Area-Routing Algorithms, Multilevel routing, Timing –Driven detailed routing, Final routing steps, Special Routing, Circuit extraction and DRC.

Text 1: [17.1,17.2,17.3 , 17.4]

RBT Levels: L3, L4

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Text Books:

1. Michael John Sebastian Smith, "Application - Specific Integrated Circuits", Addison- Wesley Professional, 2005

2. Khosrow Golshan Conexant Systems, Inc. 2007 Springer Science Business Media " Physical Design Essentials " An ASIC Design Implementation Perspective

Reference Books:

1. Neil H.E. Weste, David Harris, and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective" , Addison Wesley/ Pearson education 3rdedition, 2011
2. Vikram Arkalgud Chandrasetty, "VLSI Design: A Practical Guide for FPGA and ASIC Implementations" Springer, ISBN: 978-1-4614-1119-2. 2011
3. Rakesh Chadha, Bhasker J, "An ASIC Low Power Primer", Springer, ISBN: 978-14614-4270-7.

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Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested

- **Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**
- **Real world Problem Solving: Applying the ASIC front end and backend concepts.**

Course outcome (Course Skill Set)

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

Sl.No	Description	Blooms Level
CO1	Describe the concepts of ASIC design methodology, data path elements, logical effort	L2
CO2	Analyze the design of ASICs suitable for specific tasks, perform design entry and explain the physical design flow.	L3
CO3	Design data path elements for ASIC cell libraries and compute optimum path delay.	L3
CO4	Create floor plan including partition , routing using algorithms and EDA tools	L3,L4
CO5	Design CAD algorithms and explain how these concepts interact in ASIC design.	L3 ,L4

B. E. Electronics and Communication Engineering
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

Computer and Network Security

Course Code	BEC714B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100

CREDITS – 03

Course objectives:

This course will enable students to:

- Preparation: To prepare students with fundamental knowledge/ overview in the field of Network Security with knowledge of security mechanisms and services, Vulnerabilities in the host machines.
- Core Competence: To equip students with a basic foundation on computer as well as network security by delivering the basics of malicious software, intrusion detection, vulnerability Analysis, auditing as well as securities related to network, system, user and programs

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Show Video/animation films to explain the different concepts of Digital Signal Processing
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in a multiple representation.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.
9. Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.

MODULE-1	RBTL Level
Attacks on Computers and Computer Security: Need for Security, Security Approaches, Principles of Security Types of Attacks. **(Text2: Chapter1)** Security Mechanisms, Services and Attacks, A model for Network security **(Text1: Chapter1: 3, 4, 5, 6)**	L1, L2, L3
MODULE-2	
Malicious Logic: Introduction, Trojan Horses, Computer Viruses, Computer Worms, Other Forms of Malicious Logic, Defenses (Text 3: Chapter 12) **Vulnerability Analysis:** Introduction, Penetration Studies, Vulnerability Classification, Frameworks (Text 3: Chapter 13)	L1, L2, L3
MODULE-3	

Auditing: Definitions, Anatomy of an Auditing System, Designing an Auditing System, A Posterior Design, Auditing Mechanisms, Examples, Audit Browsing (Text 3: Chapter 14) **Intrusion Detection**: Principles, Basic Intrusion Detection, Models, Architecture, Organization of Intrusion Detection Systems, Intrusion Response (Text 3: Chapter 15)	L1, L2, L3
MODULE-4	
Network Security: Introduction, Policy Development, Network Organization, Availability and Network Flooding, Anticipating Attacks (Text 3: Chapter 16) **System Security:** Introduction, Policy, Networks, Users, Authentication, Processes, Files, Retrospective (Text 3: Chapter 17)	L1, L2, L3
MODULE-5	
User Security: Policy, Access, Files and Devices, Processes, Electronic Communications (Text 3: Chapter 18) **Program Security:** Introduction, Requirements and Policy, Design, Refinement and Implementations (Text 3: Chapter 19: Section 1, 2, 3, 4)	L1, L2, L3

Course outcomes (Course Skill Set):

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

- Explain the various types of attacks on computer and network security from malicious logic and intruders.
- Explain how to analyze the various vulnerabilities in the system which can compromise the security.
- Explain how auditing is essential to detect intrusion or suspicious activities in the system.
- Explain the process involved to provide security with respect to network, system, user and program.

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 22OB4.2, 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:

Text Book

1. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2. Atul Kahate, "Cryptography and Network Security", TMH, 2003.
3. Matt Bishop, Sathyanarayana S Venkatramanayya, "Introduction to Computer Security", Pearson Education, 2006, ISBN 81-7758-425-1

Reference Books

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

Web links and Video Lectures (e-Resources):

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

1. Experiential Learning by using free and open-source software's SCILAB or OCTAVE or Python

Automotive Electronics		Semester	7
Course Code	**BEC714C**	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	3
Examination type (SEE)	Theory		

Course objectives:

This course will enable students to:

- Understand the basics of automobile dynamics and design electronics to complement those features
- Design and implement the electronics that attribute the reliability, safety, and smartness to automobile, providing add – on comforts

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) need not be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain the functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher Order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to devise creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Automotive Fundamentals Overview – Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive systems, The Engine- Engine Block, Cylinder Head, four stroke Cycle, Engine Control, Ignition System- Spark plug, High voltage circuit and distribution, spark pulse generation, ignition timing, diesel engine, Drive Train – Transmission, drive shaft, differential, suspension, brakes, steering system, starter battery-operating principle. **(Text1: Chapter1, Text 2: Pg. 407-410)**

The Basics of Electronic Engine Control - Motivation for Electronic Engine, control – exhaust emissions, fuel economy, concept of an electronic engine, control system, definition of general terms, definition of engine performance terms, engine mapping, effect of air/fuel ration, spark timing and EGR on performance, control strategy, electronic fuel control system, analysis of intake manifold pressure, electronic ignition. **(Text1: Chapter 5)**

Module-2
Automotive Sensors – Automotive control system applications of sensors and Actuators – Variables to be measured, airflow rate sensor, strain gauge MAP sensor, Hall Effect position sensor, Magnetic Reluctance Crankshaft position sensor, Throttle angle sensor, Engine coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2 /EGO) Lambda sensors, piezoelectric Knock sensor **(Text 1: Chapter 6)** **Automotive Engine Control Actuators** – Solenide, Fuel Injector, EGR actuator, Ignition system **(Text 1: Chapter 6)**
Module-3
Digital Engine Control System- Digital Engine control features, Control modes for fuel control (Seven Modes), EGR Control, Electronic Ignition control- closed loop ignition timing, spark advance correction scheme, Integrated engine control system- secondary air management, Evaporative Emissions, Canister Purge, automatic system adjustment, system diagnostics **(Text 1: Chapter 7)** **Control Units –** Operating conditions, Design, Data Processing, Programming, Digital modules in the Control Unit, Control Unit Software **(Text 2: Pg. 196-207)**

Module-4
Automotive Networking – Bus Stem- classification, Applications in the Vehicle, Coupling of networks, Examples of Networked Vehicles **(Text 2: Pg. 85-91),** **Buses** – CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces **(Text 2: Pg. 92-151)** **Vehicle Motion Control –** Typical Cruise control system, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Cruse Control Configuration, Cruise Control Electronics (Digital Only), Antilock Brake System (ABS) **(Text 1: Chapter 8)**
Module-5
Automotive Diagnostics – Timing Light, Engine Analyzer, On-Board diagnostics, Off-Board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag Systems **(Text1: Chapter10)** **Future Automotive Electronic Systems –** Alternative Fuel Engines, Electric and Hybrid Vehicles, Fuel Cell Power Cars, Collision Avoidance Radar Warning Systems, Low tire pressure warning systems, Head Up Display, Speech Synthesis, Navigation- Navigation Sensors – Radio Navigation, Signpost Navigation, Dead reckoning navigation, Voice Recognition Cell phone Dialing, Advanced Cruise Control, Stability Augmentation, Automatic Driving Control **(Text 1: Chapter 11)**
Course Outcome (Course Skill Set) At the end of the course, students will be able to: • Describe the basics of Automobile dynamics and design electronics. • Acquire an overview of automotive components, subsystems and basics of Electronic Engine Control in today's automotive industry. • Use available automotive sensors and actuators while interfacing with microcontrollers/microprocessors during automotive system design.

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:

Text Books:

1. **William B Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.**
2. **Robert Bosch GmbH (Ed.), "Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive", 5th edition, John Wiley & Sons Inc., 2007.**

Web links and Video Lectures (e-Resources):
Related NPTEL Courses

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

- Real world problem solving using group discussion.
- Present animation for Car assembly
- Real world example of Automotive Electronics concepts.

	Radar Communication	Semester	5
Course Code	BEC714D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	3 Hours
Examination type (SEE)	**Theory**		

Course objectives: This Course will enable the students to

- Understand the concepts of Radar, types of Radar and Applications.
- Understand the various measurements in Radar and Propagation of waves.
- Understand the various types of Radar and its functions.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to RADAR: Basic Radar, Simple Radar equation, Radar Block diagram, Radar Frequencies, Applications of Radar.

The RADAR Equation: Detection of signals in Noise, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross section of Targets, Radar Cross section Fluctuations, Transmitter Power, Pulse Repetition Frequency, Antenna parameters, System Losses.

[**Text1:** 1.1 to 1.5, 2.2, 2.3, 2.6 to 2.12]

Module-2

MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Delay-Line Cancelers, Moving Target Detector, Pulse Doppler radar.

Tracking Radar: Tracking with Radar, Mono-pulse tracking, Conical Scanning and Sequential Lobing, Tracking in Range, Comparison of Trackers.

[**Text1:** 3.1, 3.2, 3.6, 3.9, 4.1, 4.2, 4.3, 4.6, 4.8]

Module-3

Information from Radar Signals: Introduction, Basic Radar Measurements, Accuracy of measurements.

Radar Clutter: Introduction, Surface-Clutter Radar equation, Land clutter sea Clutter.

Propagation of Radar Waves: Introduction, Scattering from Flat Earth, Scattering from the Round Earth's Surface, Atmospheric Refraction.

[Text1: 6.1, 6.2, 6.3, 7.1 to 7.4, 8.1 to 8.4.]

Module-4

Radar Transmitters: Introduction, Linear beam power tubes, solid state RF power sources.
Radar Receiver: Fundamentals, Receiver Noise Figure, Super heterodyne receiver, Duplexer.
[Text1: 10.1, 10.2, 10.3, 11.1 to 11.4]

Module-5

Synthetic Aperture Radar (SAR): Introduction, SAR History, General Description – Resolution, SAR Signal processing, Radar Equation of the SAR system, SAR system Design considerations.
Over-the-Horizon Radar (OTHR): Introduction, Classification, Ionospheric effects, Ray path trajectories, Principles of OTHR systems.
Secondary Surveillance Radar: Introduction, Principles of SSR, Deficiencies in SSR, Solution to deficiencies, Range performance in SSR.
[**Text-2:** 9.1 to 9.6, 14.3 to 14.6, 15.1 to 15.5]

Course outcome (Course Skill Set)

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

1. Explain the principles of Radar.
2. Analyze the tracking in radar and modelling of Radars.
3. Analyze the limitations, interference and propagation of Radar waves.
4. Describe the Radar transmitter and receiver, and modern Radars.

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 22OB4.2, 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.

Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Text Books:

1. Merrill L. Skolnik, "Introduction to RADAAR Systems", 3rd edition, Mc Graw Hill Education (India) Private Limited, 2016 (Reprint), ISBN 978-0-07-044533-8.
2. Habibur Rahman, "Fundamental Principles of RADAR", CRC Press, 2019, ISBN: 978-1-138-38779-9.

Reference Books

1. Mark A Richards, James A. Scheer, William A. Holm, "Principles of Modern RADAR", Yesdee Publishing Private Ltd, , 2012, ISBN: 978-93-80381-29-9.
2. Bassem R. Mahafza, " Radar Systems Analysis and Design using MATLAB", 4th edition, CRC press, 2022, ISBN 978-0-367-50793-0.
3. J.C. Toomay, Paul J. Hannen; "Principles of Radar", Third Edition, PHI Learning Pvt Ltd., 2011, ISBN : 978-81-203-4155-9.

Web links and Video Lectures (e-Resources):

1. **NPTEL : Radar Principles**

   https://archive.nptel.ac.in/courses/108/105/108105154/

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

1. Experiential Learning by using free and open source software's OCTAVE or Python
2. Experiential Learning / Simulation using MATLAB.

E-Waste Management		Semester	7
Course Code	**BEC 755A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- **Understanding e-waste**: To learn about e-waste, its different types, and how it's generated
- **E-waste rules and directives**: To understand the rules and directives for e-waste in different countries
- **E-waste management**: To learn how to manage e-waste throughout its life cycle
- **Environmental and health impacts**: To understand the environmental and health impacts of e-waste

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction: Preamble, What is e-waste, E-waste Sources and generation, Growth of Electrical and Electronics Industry in India, Global Context of e-waste Management, Indian Scenario on e-waste Management,

E-WASTE: E-waste Definition, Classification of e-waste, Characterization of e-waste

Text 1: Chapter 1 & 2

Module-2

Regulatory Framework: Global e-waste Regulations, Waste Electronics and Electrical Equipment (WEEE Directive 82), International norms – Basel Convention, Evolution of e-waste regulations in India, E-waste Management Rules 2016 (amendments to 2011 Rules), Regulatory Compliance Mechanisms, E-waste Management Guidelines (Text 1: 3.1 to 3.7)

Module-3

Extended Producer Responsibility (EPR): E-waste – A post Consumer Waste, E-waste value Chain, E-waste Collection Systems, Extended Producer Responsibility (EPR), Collective Responsibility, Producer Responsible Organization (PRO) (Text 2: 4.1 to 4.6)

Module-4

E-Waste Handling: Characterization & Classification, Packaging and Labelling, Transportation, Storage, Safety in Handling – Precautionary Principles: Text 1- Chapter 5

Module-5

Restrictions on Use of Hazardous Substances (ROHS): Hazardous substances in e-waste, Global ROHS compliances (ROHS Directive 84), ROHS compliance requirements in India: Text 1: Chapter 6

E-Waste Recycling: E-waste Recycling Operations, Dismantling & Segregation, Recycling & Recovery, Recycling Technologies – Text 1: Chapter 7 (7.1 to 7.4)

Course outcome (Course Skill Set)

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

1. Understand the environmental impacts of e-waste
2. Distinguish the role of various national and internal act and laws applicable for e-waste management and handling
3. Analyse the e-waste handling methods & restrictions
4. Analyze the e-waste recycling techniques

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Text Books

1. Lakshmi Raghupathy, Introduction to E-Waste Management, TERI Press, New Delhi

Reference Books:

1. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Web links and Video Lectures (e-Resources):

- https://news.mit.edu/2013/ewaste-mit

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

- Conduct market survey for the generated e-waste and its management and prepare a report
- Field visit to explore the possibility of various e-waste management techniques

Automotive Engineering		Semester	7
Course Code	**BEC755B**	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	3
Examination type (SEE)	Theory		

Course objectives:

This course will enable students to:

- Understand the basics of automobile dynamics and design electronics to complement those features
- Design and implement the electronics that attribute the reliability, safety, and smartness to automobile, providing add – on comforts

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) need not be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain the functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher Order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to devise creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Automotive Fundamentals Overview – Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive systems, The Engine- Engine Block, Cylinder Head, four stroke Cycle, Engine Control, Ignition System- Spark plug, High voltage circuit and distribution, spark pulse generation, ignition timing, diesel engine, Drive Train – Transmission, drive shaft, differential, suspension, brakes, steering system, starter battery-operating principle. **(Text1: Chapter1, Text 2: Pg. 407-410)**

The Basics of Electronic Engine Control - Motivation for Electronic Engine, control – exhaust emissions, fuel economy, concept of an electronic engine, control system, definition of general terms, definition of engine performance terms, engine mapping, effect of air/fuel ration, spark timing and EGR on performance, control strategy, electronic fuel control system, analysis of intake manifold pressure, electronic ignition. **(Text1: Chapter 5)**

Module-2
Automotive Sensors – Automotive control system applications of sensors and Actuators – Variables to be measured, airflow rate sensor, strain gauge MAP sensor, Hall Effect position sensor, Magnetic Reluctance Crankshaft position sensor, Throttle angle sensor, Engine coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2 /EGO) Lambda sensors, piezoelectric Knock sensor **(Text 1: Chapter 6)** **Automotive Engine Control Actuators** – Solenide, Fuel Injector, EGR actuator, Ignition system **(Text 1: Chapter 6)**
Module-3
Digital Engine Control System- Digital Engine control features, Control modes for fuel control (Seven Modes), EGR Control, Electronic Ignition control- closed loop ignition timing, spark advance correction scheme, Integrated engine control system- secondary air management, Evaporative Emissions, Canister Purge, automatic system adjustment, system diagnostics **(Text 1: Chapter 7)** **Control Units –** Operating conditions, Design, Data Processing, Programming, Digital modules in the Control Unit, Control Unit Software **(Text 2: Pg. 196-207)**

Module-4

Automotive Networking – Bus Stem- classification, Applications in the Vehicle, Coupling of networks, Examples of Networked Vehicles **(Text 2: Pg. 85-91),**
Buses – CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces **(Text 2: Pg. 92-151)**

Vehicle Motion Control – Typical Cruise control system, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Cruise Control Configuration, Cruise Control Electronics (Digital Only), Antilock Brake System (ABS) **(Text 1: Chapter 8)**

Module-5

Automotive Diagnostics – Timing Light, Engine Analyzer, On-Board diagnostics, Off-Board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag Systems **(Text1: Chapter10)**

Future Automotive Electronic Systems – Alternative Fuel Engines, Electric and Hybrid Vehicles, Fuel Cell Power Cars, Collision Avoidance Radar Warning Systems, Low tire pressure warning systems, Head Up Display, Speech Synthesis, Navigation- Navigation Sensors – Radio Navigation, Signpost Navigation, Dead reckoning navigation, Voice Recognition Cell phone Dialing, Advanced Cruise Control, Stability Augmentation, Automatic Driving Control **(Text 1: Chapter 11)**

Course Outcome (Course Skill Set)

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

- Describe the basics of Automobile dynamics and design electronics.
- Acquire an overview of automotive components, subsystems and basics of Electronic Engine Control in today's automotive industry.
- Use available automotive sensors and actuators while interfacing with microcontrollers/microprocessors during automotive system design.

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:

Text Books:

1. **William B Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.**
2. **Robert Bosch GmbH (Ed.), "Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive", 5th edition, John Wiley & Sons Inc., 2007.**

Web links and Video Lectures (e-Resources):
Related NPTEL Courses

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

- Real world problem solving using group discussion.
- Present animation for Car assembly
- Real world example of Automotive Electronics concepts.

	Embedded Systems Applications		Semester	7
	Course Code	**BTE755C**	CIE Marks	50
	Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
	Total Hours of Pedagogy	40	Total Marks	100
	Credits	03	Exam Hours	03
	Examination type (SEE)	Theory		

Course objectives:

- Understand the fundamental concepts, characteristics, and applications of embedded systems across various domains.
- Analyse the hardware components of embedded systems, including microcontrollers, memory, and low-power design techniques.
- Explore the role of sensors, ADCs, and actuators in embedded systems, and their interfacing with digital systems.
- Apply embedded systems design principles in real-world applications such as mobile phones, automotive electronics, RFID, and biomedical systems.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various EV Architectures.
3. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
4. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to embedded systems: Application domain of embedded systems, desirable features and general characteristics of embedded systems, model of an embedded system, microprocessor Vs microcontroller, example of a simple embedded system, figure of merit for an embedded system, classification of MCUs: 4/8/16/32 bits, history of embedded systems, current trends.

(Text: 1.1 to 1.9)

Module-2

Embedded systems-The hardware point of view: Microcontroller unit (MCU), The Processor, The Harvard Architecture, A popular 8-bit MCU: General Purpose I/O (GPIO), Clock; Memory for embedded systems: Semiconductor Memory, Random Access Memory (RAM), Static RAM (SRAM), An SRAM Chip. Low Power Design, Pull up and Pull Down Resistors.

(Text: 2.1 to 2.2.2, 2.3 to 2.3.2.2 and 2.4 to 2.5)

Module-3

Sensors, ADCs and Actuators

Sensors: Temperature Sensor, Light Sensor, Proximity/range Sensor; Analog to digital converters: ADC Interfacing, Control Interface, Data Interface; Actuators: Displays, Light Emitting Diodes (LED), Seven Segment LED; Motors: Stepper Motors, DC Motors.

(Text: 3.1.1 to 3.1.3, 3.2 to 3.2.1.2, 3.3 to 3.3.1.2 and 3.3.2 to 3.3.2.2)

Module-4

	Examples of embedded systems: Mobile phone, Automotive electronics, Radio Frequency Identification (RFID), Wireless Sensor Networks (WISENET), Robotics, Biomedical applications, Brain machine interface. (Text: 4.1 to 4.7)
	Module-5
	Embedded Design-A Systems Perspective: A Typical Example, Product Design, The Design Process, Testing, Bulk Manufacturing. (Text: 18.1 to 18.5)

Course outcome (Course Skill Set)

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

1. Understand the fundamental concepts and characteristics of embedded systems, including their classification and modern trends.
2. Analyse the architecture and hardware components of MCUs and their role in embedded systems.
3. Apply knowledge of sensors, ADCs, and actuators for interfacing and control in embedded systems.
4. Evaluate real-world embedded system applications such as mobile phones, automotive electronics, RFID, and robotics.
5. Develop an understanding of the embedded design process, from concept to bulk manufacturing, including testing and product design.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Das, LyLa B.. Embedded Systems: An Integrated Approach. India: Pearson Education India, ISBN 9788131787663, 2013.

Web links and Video Lectures (e-Resources):

- Embedded Systems: https://nptel.ac.in/courses/108102045
- Embedded Systems Design: https://onlinecourses.nptel.ac.in/noc20_cs14/preview
- Android Mobile Application Development: https://onlinecourses.swayam2.ac.in/nou24_ge66/preview

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

- Conduct market survey for latest home appliances and compare specifications of reputed brands and prepare a report
- Students can interface a temperature sensor with an ADC and display the digital output on a seven-segment display, demonstrating sensor integration with actuators.

	Sensors and Actuators	Semester	7
Course Code	**BEC755D**	CIE Marks	50
Teaching Hours/Week(L:T:P)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To provide the fundamental knowledge about sensors and measurement system.
- To impart the knowledge of static and dynamic characteristics of instruments and understand the factors in selection of instruments for measurement.
- To discuss the principle, design and working of transducers for the measurement of physical time varying quantities.
- To discuss basics of signal conditioning and signal conditioning equipment.

Teaching-Learning Process (General Instructions)

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

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various techniques.
3. Encourage collaborative (Group) Learning in the class.
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical Thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Sensors and Transducers: Introduction, Definition of Sensors and Transducers, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers. **(Text 1:16.1 to 16.4)**

Measurement: Introduction to measurement and Instrumentation, Definition, significance of Measurement, Methods of measurement, Modes of measurement, Elements of generalized measurement system with example. Input-output configuration of measuring instruments and measurement systems, Applications of measurement systems. **(Text 1:3.1 to 3.7)**

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

Module-2

Static and Dynamic Characteristics of instruments: Introduction, Definition relating to measuring instruments.

Static characteristics - Accuracy, Errors and Correction, Static calibration Range and span. Scale readability Repeatability and Reproducibility, Drift, Accuracy and Precision, Sensitivity, Linearity, Hysteresis, Threshold and Resolution, Dead Zone and Dead Time, Loading Effects and Noise.

Dynamic Characteristics– Dynamic Response, Dynamic characteristics of a measurement system, Dynamic analysis of a measurement system, Zero, First and Second order system.

(Text 1: 3.8, 3.8.1 to 3.8.4.4)

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

Module-3	
Measurement of Temperature: Introduction, Temperature measuring instruments, RTD, Thermistors, Thermocouple Thermometers, Radiation Pyrometers, Optical Pyrometers. **(Text 1: 21.2, 21.2.1 to 21.2.7)** **Measurement of Displacement:** Introduction, Principles of Transduction –Variable resistance devices, Variable Inductance Transducer, Induction Potentiometers, Synchros and Resolvers, Variable Capacitance Transducer, Hall Effect Devices, Proximity Devices, Digital Transducer. **(Text 2: 4, 4.1 to 4.3)**	
Teaching-Learning Process	Chalk and Talk method, PowerPoint Presentation, Virtual instrumentation Lab to demonstrate the characteristics of sensors **RBT Level:** L1, L2, L3
Module-4	
Measurement of Strain: Introduction, Factors affecting strain measurements, Types of Strain Gauges, Theory of operation of resistance strain gauges, Types of Electrical Strain Gauges –Wire gauges, unbounded strain gauges, foil gauges, semiconductor strain gauges, Thin film Guages (principle, types & list of characteristics only), Strain gauge Circuits – Wheatstone bride circuit, Applications. **(Text 2: 5, 5.1 to 5.5, 5.8, 5.8.1, 5.10)** **Measurement of Force & Torque:** Introduction, Force measuring sensor –Load cells – column types devices, proving rings, cantilever beam, pressductor. Hydraulic load cell, electronic weighing system. **Torque measurement:** Absorption type, transmission type, stress type & deflection type. **(Text 2: 10.1,10.2,10.2.1,10.2.2,10.2.3,10.2.6,10.7,10.8,10.9)**	
Teaching-Learning Process	Chalk and talk method, PowerPoint Presentation, Virtual instrumentation Lab to demonstrate the characteristics of sensors **RBT Level:** L1, L2, L3
Module-5	
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. **(Text 1: 17.1 to 17.8)** **Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion. **(Text 1: 18.1 to 18.4)**	
Teaching-Learning Process	Chalk and Talk method, PowerPoint Presentation **RBT Level:** L1, L2, L3

Course outcomes (Course Skill Set)

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

1. Discuss the fundamental concepts related to sensors and measurement, functional elements of measurement system, I/O Characteristics of measurement system.
2. Interpret and analyse the static and dynamic characteristics of instruments.
3. Elucidate the working principle and usage of different transducers for temperature, and displacement measurement.
4. Discuss the principle and working of strain, force and torque measurement.
5. Analyze the signal conditioning and signal conditioning equipment.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Two assignments each of **10 Marks**

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

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

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

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

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

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

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

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

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Text Books:

1. Electrical and Electronic Measurements and instrumentation, R.K Rajput, S. Chand, 4th Edition, 2015.
2. Instrumentation: Devices and Systems, C S Rangan, G R Sarma, V S V Mani, 2nd Edition (32 Reprint), McGraw Hill Education (India), 2014.

Reference Books :

1. Electrical and Electronic Measurements and Instrumentation, A K Sawhney, 17th Edition, (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.
2. A Course in Electronics and Electrical Measurements and Instruments, J.B. Gupta, Katson Books, 13th Edition, 2008.