Progressive Education Society's

Modern College of Engineering

Department of Electronics & Telecommunication Engineering

Curriculum Booklet
Final Year
2015-Pattern
Semester -II

Vision of Institute

"To create a collaborative academic environment to foster professional excellence and ethical values"

Mission of the Institute

1. To develop outstanding engineers & professionals with high ethical standards capable of creating and managing global enterprises.
2. To foster innovation and research by providing a stimulating learning environment.
3. To ensure equitable development of students of all ability levels and backgrounds.
4. To be responsive to changes in technology, socio-economic levels and environmental conditions.
5. To foster and maintain mutually beneficial partnerships with alumni and industry.

Vision of Department

To impart holistic Education in Electronics and Telecommunication Engineering to create engineers equipped to meet the challenges of a dynamic, global environment

Mission of Department

1. To impart quality Education in the field of Electronics, Communication and Signal processing, by providing a comprehensive learning experience.
2. To provide avenues to encourage students to continue education in diverse fields.
3. To develop competent Engineers, well-versed in multi-disciplinary fields.
4. To inculcate ethical and professional values in our students to endow society with responsible citizens.

Program Educational Objectives

The graduates of Electronics and Telecommunication Engineering Department of P.E. S's MCOE will

1. Apply design and development skills related to E&TC Engineering to solve real life problems
2. Pursue careers as Entrepreneurs, Engineers or Managers in Private/Government sectors or continue their education in the same or multi-disciplinary fields.
3. Practice ethical standards, adhere to social responsibilities and lead teams of professionals in the global environment.

Program Specific Outcomes

At the time of graduation, the students of the ENTC department of PES's MCOE, will be able to

1. Apply the Knowledge in E&TC engineering to understand, evaluate, design, or implement the electronics, communication, embedded or information systems or sub- systems using conventional or modern tools/techniques
2. Take up jobs in Government or private sectors, undertake research, create jobs or pursue further studies in any of the fields of E&TC, in India or Abroad.
3. Incorporate ethical & social responsibility to complete projects in the E&TC and allied fields and use effective written and oral communication skills to present the work.

Program Outcome

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice**.**

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in

diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions**.**

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Structure

Semester II												
Course Code	**Course**	**Teaching Scheme Hours / Week**			**Semester Examination Scheme of Marks**						**Credit**	
		Theory	**Tut**	**Pract**	**In-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH/TW**	**PR+OR**
404189	Mobile Communication	3	--	--	30	70	--	--	--	100	3	--
404190	Broadband Communication Systems	4	--	--	30	70	--	--	--	100	4	--
404191	Elective III	3	--	--	30	70	--	--	--	100	3	--
404192	Elective IV	3	--	--	30	70	--	--	--	100	3	--
404193	Lab Practice –III (MC+BCS)	--	--	4	--	--	50	50	--	100	--	2
404194	Lab Practice –IV (Elective III)	--	--	2	--	--	--	--	50	50	--	1
404195	Project Stage II	--	6	-	--	--	150	--	50	200	--	6
	Audit Course 6	--	--	--	--	--	--	--	--	--		

Total	13	6	6	120	280	200	50	100	750	13	9
Total Credits										**22**	

Elective III	**Elective-IV**	**Audit Course 6**
1. Machine Learning 2. PLC s and Automation 3. Audio and Speech Processing 4. Software Defined Radio 5. Audio Video Engineering	1. Robotics 2. Biomedical Electronics 3. Wireless Sensor Networks 4. Renewable Energy Systems 5. Open Elective*	1. Team Building, Leadership and Fitness 2. Environmental issues and Disaster Management

1.Name of the Course -Mobile Communication(404189)

Weekly Work Load(in Hrs.)	Lecture	Tutorial	Practical
	3	-	2

Online/ In-Sem.	Theory End Sem.	Practical	Oral	Term-work	Total Marks	Credit (Theory/TW) and (PR+OR)
30	70	50	-	50	100	3 and 2

1.1 Syllabus

Unit I-Switching techniques for Voice and Data **8 Hrs**

Switching techniques for Voice: Manual Switching System, Electronic Switching System andTime Division Switching. Single Stage networks, Gradings, Two stage and Three stage networks. Synchronization,

Control of switching systems: Call processing Functions, Common Control, Reliability,Availability and Security.

Switching techniques for Data: Circuit switching, Message Switching and packet Switching in perceptive with mobile communication.

Unit II - Traffic Engineering and Signaling **8Hrs**

Telecommunication Traffic: Unit of Traffic, Traffic measurement, A mathematical model,Lost-call systems: Theory, traffic performance, loss systems in tandem, traffic tables. Queuingsystems: Erlang Distribution, probability of delay, Finite queue capacity, Systems with a singleserver, Queues in tandem, delay tables and application of delay formulae.

Signaling: Customer line signaling. FDM carrier systems, PCM signaling, Inter-register signaling, Common channel signaling, CCITT signaling system and Digital customer linesignaling.

Unit III - Cellular Concept **8Hrs**

Introduction to cellular telephone system, Cellular concept: Expansion of mobile system capacity through frequency reuse, Cell geometry, Selection of cluster size, Cell splitting and sectoring, Coverage and capacity in cellular system and Handoff strategies. **Propagation Mechanism:** Free space and two ray propagation model, Basic propagation mechanism. Hata outdoor propagation model.

Small Scale Fading and Multipath: Types of Small scale fading, Small scale multipathpropagation, Impulse response model of multipath channel and Small scale multipath measurements.

Unit IV - GSM Fundamentals **8 Hrs**

Introduction, Architecture of GSM, characteristics of GSM standards, services, Radiotransmission

parameters in GSM System, Applications.

Unit V - GSM Channels and Services **8 Hrs**

Traffic and Logical Channels in GSM, GSM time hierarchy, GSM burst structure, Descriptionof call setup procedure, Handover mechanism in GSM, Security in GSM.
Data transmission in GSM: Data Services, SMS, HSCSD, GPRS, EDGE.
Multiple Access Techniques-TDMA, CDMA and OFDMA.

Unit VI - Evolution of Mobile Technologies **6 Hrs**

Evolution of Mobile Generation and its comparison (GSM & CDMA) **Overview of LTE:**LTE basics, LTE frame structure, LTE Design parameters with Standardization andArchitecture of LTE. **Overview of 5 G Networks :** Comparison of 4G and 5G technology,Opportunities and requirements in 5G network, Open Wireless Architecture of 5G networkand Disruptive technologies for 5G.

1.2 Course Objectives

1. To make aware about the basic principles of Telecommunication switching, traffic and networks.
2. To explain basic concepts of cellular system, wireless propagation and the techniques used to maximize the capacity of cellular network.
3. To describe the GSM fundamentals and CDMA systems.
4. To introduce evolution of mobile technologies such as Long Term Evolution (LTE) and 5G Networks.

1.3 Course Outcome

On completion of the course, students will be able to

1. Apply the concepts of switching technique and traffic engineering.
2. Analyze radio channel, system capacity and propagation mechanisms.
3. Explain the GSM fundamentals, channels, services and CDMA systems.
4. To give overview of LTE and 5G technologies.

1.4 Text Books

1. Thiagarajan Vishwanathan, ―Telecommunication Switching Systems and Networks; PHI Publications
2. Theodore Rappaport, ―Wireless Communications Principles and Practice‖ Second Edition, Pearson Education

1.5 Reference Books

1.Fei Hu, —"Opportunities in 5G Networks : A research& development perspective", CRC Press

2. J. E. Flood , —"Telecommunications Switching, Traffic and Networks", PearsonEducation

3.Krzyszt of Wesolowski, —"Mobile Communication Systems", Wiley Student Edition

4.John C. Bellamy, —"Digital Telephony", Third Edition; Wiley Publications

5.Mischa Schwartz, —"Mobile Wireless Communications", Cambridge University Press

6.AdityaJagannatham, "Principles of Modern Wireless Communication Systems"

1.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

1.www.nptel.ac.in

*2.*www.nptelvideos.in

1.7 Teaching Plan

Overview of Teaching Plan:

Sr. No.	Unit	Topics to be covered	Book Referred	Total Lecture Planned	CO Mapped
1	I	Switching techniques for Voice and Data	T1, R2	8L	1
2	II	Traffic Engineering and Signaling	R2	8L	1
3	III	Cellular Concept	T2	6L	2
4	IV	GSM Fundamentals	R3	3L	3
5	V	GSM Channels and Services	R3	7L	3
6	VI	Evolution of Mobile Technologies	R2, R3, R6	6L	4

1.8 Unit wise Lecture Plan

1.8 a. Unit No I: Switching techniques for Voice and Data

Pre-requisites:- Basic concept of switching

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Switching techniques for Voice	-	-
2	Control of switching systems	-	-
3	Switching techniques for Data	Computer Networks and security	BE-I

Objectives: - To Teach

1. To introduce different types of switching techniques and its functions
2. To introduce different types of communication networks
3. To describe the concept of grading and their various types

Outcomes: - Students will be able to

1. Explain different types of switching techniques and its functions
2. Explain different types of communication networks and grading
3. Analyze communication networks and grading systems.

Lecture No.	Details of the Topic to be covered	References
1	**Switching techniques for Voice**: Manual Switching System,Electronic Switching System and Time Division Switching.	T1 Ch1(pg.16)R2 Ch3(pg.76) R2 Ch6 (pg.156 onwards)
2, 3	Single Stage networks, Gradings	R2 Ch5 (pg.117-126)
4	Two stage and Three stage networks.	R2 Ch5 (pg.129-136)

5	Synchronization.	R2 Ch6 (pg.170)
6	**Control of switching systems:** Call processing Functions	R2 Ch7(pg.177-186)
7	Common Control, Reliability, Availability and Security.	R2 Ch7(pg.186-193) T1 Ch4(pg.93)
8	**Switching techniques for Data:** Circuit switching, MessageSwitching and packet Switching in perceptive with mobile communication.	T1Ch3(pg49 – 53)

All the questions are mapped with PI

1.1.1 Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems.

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions (Designing of Grading – Problems)

2.3.2 Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.

2.4.1 Apply engineering mathematics and computations to solve mathematical models.

Question Bank: Theory

Q.1	Explain in brief manual and electronic switching.	CO1
Q.2	Explain the functions of a switching system.	CO1
Q.3	Explain in brief the concept of i) space division switching ii) time division switching.	CO1

Q.4	Explain the concept of time slot interchange (TSI) in time division switching.	CO1
Q.5	Explain the design procedure for 'N' by 'N' switch with two stages and no. of links = N. What is the total no. of cross- points required?	CO1
Q.6	What is the need of reliability, availability and security in switching network?	CO1
Q.7	Design two stage switching network for connecting 200 incoming trunks to 200 outgoing trunks & find number of cross points.	CO1
Q.8	With a neat diagram explain the term Progressive grading in detail.	CO1
Q.9	Design a grading for connecting 20 trunks to switches having 10 outlets.	CO1
Q.10	Calculate unavailability of a dual processor system with MTBF=1500 Hrs. and MTTR=8 Hrs. for 30 years.	CO1
Q.11	Calculate availability of a dual processor system for a period of 20 years if its MTBF=3300 Hrs. and MTTR=6 Hrs.	CO1
Q.12	Describe and differentiate between circuit switching, Message Switching and Packet switching.	CO1
Q.13	Explain the design procedure for three stage switching network. What is the total no. of cross- points required?	CO1
Q.14	Explain the design procedure for Expander and Concentrator in two and three stage switching network. Derive the total number of cross-points required for Expander and Concentrator?	CO1

1.8 b. Unit No II

Traffic Engineering and Signaling

Pre-requisites: - Basic concept of probability theory, PCM, FDM and TDM

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	**Telecommunication Traffic**	-	-
2	**Signaling**	Digital Communication	TE

Objectives: -

1. To learn telecommunication traffic and its mathematical models
2. To describe the concept of signaling and their various types

Outcomes: - Students will be able to,

1. Analyze telecommunication traffic and its mathematical models
2. Explain different types of signaling

Lecture No.	Details of the Topic to be covered	References
1	Telecommunication Traffic: Unit of Traffic, Traffic measurement, A mathematical model,	R2 Ch4
2	Lost- call systems:Theory, traffic performance, loss systems in tandem, traffic tables.	R2 Ch4
3	Queuing systems: Erlang Distribution, probability of delay, Finite queue capacity,	R2 Ch4
4	Systems with a single server, Queues in tandem, delay tables and application of delay formulae.	R2 Ch4
5	Signaling: Customer line signaling. FDM carrier systems,	R2 Ch8
6	PCM signaling, Inter-register signaling, Common channel signaling,	
7	CCITT signaling system and	
8	Digital customer line signaling.	

All the questions are mapped with PI

1.1.1 Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems.

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions (Designing of Grading – Problems)

2.3.2 Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.

2.4.1 Apply engineering mathematics and computations to solve mathematical models.

Question Bank: Theory

Q.1	Derive the first Erlang Distribution for Lost call systems	CO1
Q.2	Explain the assumptions used in second Erlang Distribution for Queuing systems.	CO1
Q.3	Define & explain i) Grade of service, ii) Average holding time, iii) call completion rate, iv) Erlang & CCS	CO1
Q.4	Explain the assumptions-i) Pure chance Traffic, ii) Statistical equilibrium.	CO1
Q.5	Write a short note on i) Probability of delay, ii) Queues in tandem	CO1
Q.6	Define Grade of service & blocking probability for lost call system and explain Its significance.	CO1
Q.7	A group of 5 trunks is offered 2E of traffic .Find i) GOS, ii) Probability that only one trunk is busy, iii) Probability that only one trunk is free, iv) Probability that at least one trunk is free.	CO1
Q.8	During busy hour, 1200 calls were offered to a group of trunks & 6 calls were lost.The average call duration was 3 minutes. Find i) Traffic offered, ii) Traffic carried, iii) Traffic lost, iv) Grade of service, v) total duration of periods of congestion	CO1
Q.9	On an average, one call arrives every 5 seconds. During a period of 10 seconds. What isprobability that i) No call arrivals, ii) 1 call arrives, iii) 2 call arrives, iv) more than 2 call arrives	CO1
Q.10	A group of 20 trunks provides GOS 0.01 when offered 12 E of traffic. i) How much is the GOS improved if one extra trunk is added to the group? ii) How much is the GOS deteriorated if one trunk is out of service?	CO1
Q.11	On average, during the busy hour, a company makes 150 outgoing calls of averageduration 2 Minutes. It receives 150 incoming calls of average duration 3 minutes. Find the i) outgoing traffic, ii) in coming traffic, iii) total traffic.	CO1
Q.12	During busy hour, on an average a customer with a single telephone line makes 3 calls &receives 3 calls. The average call duration is 2 min. What is the probability that a caller will find line engaged?	CO1
Q.13	In a telephone system average call duration is 2 min. A call has already lasted 4 min. What is the probability that, i) Call will last at least another 4 min, ii)Call will end withinnext 4 min	CO1
Q.14	On an average, during busy hour, a company makes 120 outgoing calls of averageduration 2 min. It receives 200 incoming calls of average duration 3 min. Find the i) outgoing traffic , ii) in coming traffic , iii) total traffic	CO1
Q.15	Differentiate between In-Channel and Common channel signaling.	CO1

Q.16	Write a short note on the following: 1. Digital Customer line signaling 2. PCM Signaling 3. Inter register signaling 3. CCITT Signaling system	CO1
Q.17	A group of 20 trunks provides GOS 0.01 when offered 12 E of traffic. **i)** How much is the GOS improved if one extra trunk is added to the group? **ii)** How much is the GOS deteriorated if one trunk is out of service?	**CO1**

1.8 b. Unit No III

Cellular Concept

Pre-requisites: - Basic concepts of Wave propagation

Sr.No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Cellular Concept	-	-
2	Propagation Mechanism	-	-
3.	Small Scale Fading and Multipath	-	-

Objectives: - To Teach

1. To learn and understand basic concepts of cellular system, wireless propagation and the Techniques used to maximize the capacity of cellular network.

Outcomes: - Students will be able to,

1. Analyze radio channel and cellular capacity and its propagation mechanisms.

Lecture No.	Details of the Topic to be covered	References
1	Introduction to cellular telephone system, Cellular concept , Expansion of mobile system capacity through frequency reuse,	T2 Ch3
2	Cell geometry, Selection of cluster size, Cell splitting and sectoring,	
3	Coverage and capacity in cellular system and Handoff strategies.	

4	**Propagation Mechanism:** Basic propagation mechanism, Hata outdoor propagation model, Free space and two ray propagation model,	T2 Ch4
5	**Small Scale Fading and Multipath:** Types of Small scale fading, Small scale multipath propagation,	T2 Ch5
6	Impulse response model of multipath channel and Small scale multipath measurements.	

All the questions are mapped with PI

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.3.2 Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.

2.4.1 Apply engineering mathematics and computations to solve mathematical models

Question Bank: Theory

Q.1	What is the concept of frequency reuse in Mobile Cellular System	CO2
Q.2	What is Handoff? Why is it necessary in Mobile Cellular System? a. What is Handoff Threshold? How is it use in making the handoff successful? b. What is Mobile Assisted Handoff? c. How does the speed of the mobile affect handoff strategies? d. What is prioritizing Handoffs?	CO2
Q.3	What are different ways to improve capacity & coverage in Mobile Cellular System	CO2
Q.4	With a neat diagram explain Cell Splitting. a. What are the changes in area covered, capacity and transmit power if original radius of the cell R is changed to R/2	CO2

Q.5	What is Cell Sectoring? a. How does it help to improve the capacity of Mobile CellularSystem? b. Explain two types of sectoring and difference in number of interferer in both	CO2
Q.6	What is a Microcell zone concept? How is it used to improve capacity?	CO2
Q.7	Discuss factors influencing Small scale fading?	CO2
Q.8	Explain Impulse response model of Multipath channel?	CO2
Q.9	Derive the formula $P_t = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}$	CO2
Q.10	What is Doppler shift? Derive the Doppler frequency in terms of angle θ between direction of moving vehicle and arrival of transmitted signal.	CO2
Q.11	Explain Hata outdoor propagation model?	CO2
Q.12	For path loss exponent n=3, frequency reuse factor =7 a. Find S/I of a cellular system. b. Does it satisfy min S/I requirement of 15 dB c. If not what should be done to increase the S/I	CO2

1.8 c. Unit No.-IV

GSM Fundamentals

Pre-requisites: - Basic cellular concept

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Architecture of GSM	-	-

Objectives: - To Teach

1. To describe the architecture of GSM

Outcomes: - Students will be able to

1. Explain the architecture of GSM

Lecture No.	Details of the Topic to be covered	References

1	Introduction, Architecture of GSM,	R3 Ch7(Pg176-179)
2	characteristics of GSM standards,	
3	GSM services,	
4	Radio transmission parameters in GSM System, Applications.	R3 Ch7(Pg179-180)

All the questions are mapped with PI

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.

Question Bank: Theory

Q.1	Explain the frequency allocation of GSM and list out GSM frequency band.	CO3
Q.2	Draw a neat diagram of GSM Architecture and explain the function of each block in it	CO3
Q.3	Explain various GSM services.	CO3
Q.4	Write short note on basic radio transmission parameters of the GSM system	CO3
Q.5	Write short note on GSM applications.	CO3
Q.6	Explain RF power control mechanism in GSM system.	CO3
Q.6	List out various GSM parameters.	CO3
Q.8	Explain typical GSM transmitter and receiver system	CO3
Q.9	Explain characteristics of GSM standard.	CO3
Q.10	Why GMSK is preferred modulation scheme for GSM standards.	CO3

1.8 e. Unit No V
GSM Channels and Services

Pre-requisites: - Basic cellular concept

Sr.No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year

1	GSM Channels	-	-
2	Data transmission in GSM	-	-
3	Multiple Access Techniques	Digital Communication	TE

Objectives: -To Teach

1. To elaborate the logical and physical channels, burst structure and its types, call flow procedureand handoff mechanism

Outcomes: - Students will be able to

1. Classify the logical and physical channels,

2. Illustrate burst structure and its types, call flow procedure and handoff mechanism

Lecture No.	Details of the Topic to be covered	References
1	Traffic and Logical Channels in GSM, GSM time hierarchy,	R3 Ch7(Pg180-182)
2	GSM burst structure,	R3 Ch7(Pg183-187)
3	Description of call setup procedure, Handover mechanism in GSM	R3 Ch7(Pg187-196)
4	Security in GSM.	
5	**Data transmission in GSM**: Data Services, SMS, HSCSD	R3 Ch9(Pg220-247)
6	GPRS, EDGE.	
7	**Multiple Access Techniques**- TDMA, CDMA and OFDMA.	

All the questions are mapped with PI

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.

Question Bank: Theory

Q.1.	State the different types of the channels used in GSM and explain their use in brief.	CO3
Q.2.	With a proper diagram explain the time slot hierarchy of GSM system.	CO3
Q.3.	Draw the format of different GSM burst structures and explain each one in detail.	CO3
Q.4	With a proper diagram explain a) Mobile initiated call set up and b) Mobile terminated call set up	CO3
Q.5.	With a neat diagram explain a) Intra-cell Handover b) Inter-cell Handover c) Inter-BSC Handover d) Inter-MSC Handover	CO3
Q.6.	State and explain data services in GSM	CO3
Q.7	With the suitable diagram, explain the frame structure of - a) Mobile terminated SMS messages b) Mobile originated SMS messages.	CO3
Q.8	Write short note on HSCSD.	CO3
Q.9	Draw and explain GPRS architecture.	CO3
Q.10	State and explain different logical channels used in GPRS.	CO3
Q.11	Write short note on GPRS services.	CO3
Q.12	Differentiate between TDMA and CDMA.	CO3
Q.13	Write a short note on OFDMA	CO3
Q.14	**Discuss and compare the security mechanism in GSM and CDMA.**	**CO3**

1.8 f . Unit No: VI

Evolution of Mobile Technologies

Pre-requisites: Basic concept of 2G, 3G

Sr. No.	Broad Topic to becovered	Linkage with previous subjects in the curriculum	Yea r
1	Evolution of Mobile Generation and its comparison (GSM &CDMA)	-	-
2	Overview of LTE	-	-
3	Overview of 5 G Networks	-	-

Objectives: To Teach

1. To overview 4G LTE and 5G technologies.

Outcomes: Students will be able to

1. Describe and compare the 4G and 5G mobile technologies.

Lecture No.	Details of the Topic to be covered	References
1	Evolution of Mobile Generation and its comparison(GSM & CDMA)	R4: Chapter 1
2	**Overview of LTE :** LTE basics, LTE frame structure,	R4: Chapter 2, Chapter 6
3, 4	LTE Design parameters with Standardization and Architecture of LTE	
5	**Overview of 5 G Networks :** Comparison of 4G and 5G technology,	R2, R3
6	Opportunities and requirements in 5G network,	
7	Open Wireless Architecture of 5G network and Disruptive technologies for 5G.	

All the questions are mapped with PI

1.4.1. Apply E & TC concepts to solve engineering problems.

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

Question Bank: Theory

Q.1	Explain the evolution of mobile generation and state the disadvantages of 2G standards.	CO4
Q.2	Describe the features of LTE and differentiate between LTE and LTE advanced.	CO4
Q.3	Explain in detail LTE design parameters with standardization and architecture of LTE.	CO4
Q.4	Compare 4G and 5G technology.	CO4
Q.5	Explain in detail 5G standardization, requirement and opportunities.	CO4
Q.6	Explain in detail open wireless architecture of 5G network.	CO4
Q.7	What are disruptive technologies for 5G.	CO4
Q.8	Why millimeter waves are being considered for 5G technology	CO4

1.9 List of Practical

Sr. No.	Name of the Practical	CO Addressed
1	To study EPABX system.	**CO1**
2	Set up and carry out experiment on PSTN TST switch.	**CO1**
3	Set up and carry out experiment on GMSK modulation.	**CO3**
4	Set up and carry out experiment on spreading Sequences.	**CO3**
5	Write a program to measure Bit Error Rate in presence of Rayleigh Fading model.	**CO2**
6	Write a program to elaborate lost call system/delayed system used in analysis of Voice/ data traffic.	**CO1**
7	Set up and carry out experiment on AT commands.	**CO3**
8	Write a program to measure Bit Error Rate in presence of Hata propagation model.	**CO2**
9	To study VoIP call routing process.	**CO4**

2.Name of the Subject – Broadband Communication Systems.

Weekly Work Load(in Hrs)	**Lecture**	**Tutorial**	**Practical**
	3 Hrs/week		**2 Hrs/week**

Online/ In-sem	**Theory**	**Practical**	**Oral**	**Term-work**	**Total Marks**	**Credit**
30	**70**	**50**		**50**	**100**	4

2.1 Syllabus

Unit I: Light wave System Components 6L

Key Elements of Optical Fiber Systems, Optical Fibers as a Communication Channel: Optical Fiber Modes and Configurations , Mode Theory for Circular Waveguides , Single-mode Fibers, Graded-index Fiber Structure, Signal Degradation in Optical Fibers. Optical Sources: Basic Concepts and characteristics of LEDs and LASERs. Photodetectors: Basic Concepts, Common Photodetectors.

Unit II: Lightwave Systems 6L

System Architectures, Point-to-Point Links: System Considerations, Design Guidelines: Optical Power Budget, Rise Time Budget, Long-Haul Systems.

Unit III: Multichannel Systems 6L

Overview of WDM, WDM Components: 2 x 2 Fiber Coupler, Optical Isolators and Circulators, Multiplexers and De-multiplexers, Fiber Bragg Grating, FBG applications for multiplexing and De-multiplexing function, Diffraction Gratings, Overview of Optical Amplifiers: SOA, EDFA and RFA in brief.

Unit IV: Orbital Mechanics and Launchers 6L

History of Satellite Communication, Orbital Mechanics, Look angle determination, Orbital perturbations, Orbital determination, Launchers and Launch Vehicles, Orbital effects in communication system performance.

Unit V: Satellites 6L

Satellite Subsystems, Attitude and control systems (AOCS), Telemetry, Tracking, Command and Monitoring, Power systems, Communication subsystems, Satellite antennas, Equipment Reliability and space qualification.

Unit VI: Satellite Communication Link Design 6L

Introduction, Basic transmission Theory, System Noise Temperature and G/T Ratio, Design of Downlinks, Satellite Systems using Small Earth Stations, Uplink Design, Design of Specified C/N: Combining C/N and C/I values in Satellite Links, System Design Examples

2.2 Course Objectives

- To familiarise students with the three primary components of a typical fibre-optic communication system.
- To explain Power Budget and Rise Time Budget for Optical Communication System.
- To introduce concept of WDM and Optical Amplifier.
- To explore the basics of orbital mechanics and Satellite Communication System.
- To explain satellite link design for up link and down link

2.3 Course Outcomes

After successfully completing the course students will be able to:

1. Explain working principles of the key components of Fibre Optic Communication system. (Unit-I, BT-2, understand)
2. Estimate Power and Rise Time Budgets for a typical fibre optic link.(Unit-II, BT-3, apply)
3. Discuss working principle of optical Amplifier, WDM and its components. (Unit-III, BT-2, understand)
4. Describe various satellite subsystems, key components and Orbital effects in Satellite Communication Systems. (Unit-IV, V, BT-2, understand)
5. Estimate satellite link budget for up-link, down-link, and overall link. (Unit-VI, BT-3, Apply)

2.4 Text Books:

1. Gerd Keiser, "Optical fiber Communications", Tata McGraw Hill, 4th edition
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt "Satellite Communications", John Wiley & Sons.

2.5 Reference Books:

1. Govind P. Agrawal, Fiber-Optic Communication Systems, Wiley, 3rd edition.
2. Dennis Roody, "Satellite Communications", McGraw Hill

2.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

1.Senior John M., “Optical Fiber Communication: Principles and Practices”

2.www.nptl.com

2.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	Book Referred	Total Lecture Planned	CO Addressed
1	I	Light wave System Components	T1, R1	6	CO1 1.4.1-3 2.2.4-3 2.3.1- 2
2	II	Lightwave Systems	T1, R1	6	CO2 1.4.1 -3 2.1.2-3 2.3.2-3 4.3.2-3 4.3.3-3
3	III	Multichannel Systems	T1, R1	6	CO3 1.4.1 –3 2.1.2-3
4	IV	Orbital Mechanics and Launchers	T2, R2	6	CO4 1.4.1-3 2.2.4-3 2.3.1- 3

5	V	Satellites	T2, R2	6	CO4 1.4.1-3 2.2.4-3 2.3.1- 3
6	VI	Satellite Communication Link Design	T2, R2	6	CO5 2.1.2-3 2.3.2-3 4.3.2-3 4.3.3-3

2.8 Unit wise Lecture Plan

2.8 a. Unit No.-I

Pre-requisites:-

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Semiconductor Devices, Basics of Optical Fiber Cable	Basic Electronics Engineering	F.E.
2	Photodetector, LED, LASER	Electronic Devices And Circuits	S.E.

Objectives:-

- To understand the fundamentals of the primary components viz. optical fibre, optical source and the optical detector2. Explain Sampling, sampling theorem and aliasing.

- To familiarize students with the three primary components of a typical fibre-optic communication system (the fiber, the source and the detector)

Outcomes:-

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

CO1. Analyze the principle of Modal propagation of light through an Optical Fibre and Explain working principles of the key components of a typical Fibre Optic Communication system.

Lecture No.	**Details of the Topic to be covered**	**References**	**CO Addressed**
1	Key Elements of Optical Fiber Systems, Optical Fibres as a Communication Channel.	T1:1.6, T1:2.2_pg 35-36	**CO1** 1.4.1-3, 2.2.4-3, 2.3.1- 2
2	Optical Fiber Modes and Configurations.	T1:2.3.1, 2.3.2, 2.3.3, 2.3.4	
3	Mode Theory for Circular Waveguides	T1:2.4.1, 2.4.2	
4	Single-mode Fibres, Graded-index Fiber Structure	T1:2.5-2.6	
5	Signal Degradation in Optical Fibres.	T1:3.1, 3.2.1	
6	Optical Sources: Basic Concepts and characteristics of LEDs and LASERs.	R1:3.2.1,3.2.2,3.3.1,3.3.2	

7	Photo detectors: Basic Concepts, Common Photodetectors.	R1:4.1.1,4.1.2, R1:4.2_pg 136-140, 4.2.3_pg142-144	

Question Bank: UNIT I

Theory Questions-CO1 (1.4.1-3, 2.2.4-3, 2.3.1- 2)

Q. 1	With neat block diagram, explain the features of the key elements of an Optical fiber transmission link & what are the advantages of fiber optics communication.
Q. 2	With reference to mode theory for optical propagation explain the terms: Phase Velocity, Group Velocity, Group delay, Mode Field diameter and Cut-off wavelength.
Q. 3	Compare i) Multimode and single mode fibres. ii) Step index and Graded index fibers.
Q. 4	Explain the following mechanisms associated with optical fibers: Scattering Losses Absorption Losses
Q. 5	An installed fiber has the following specifications: - Core diameter = 62.5μm; NA = 0.275
	and its operating wavelength is 1310nm. Calculate, the V number, the number of mode if the fiber is graded index and has the parabolic refractive index profile. What the number of mode if the fiber is step index type.
Q. 6	A silica optical fiber with core diameter large enough to be considered by ray theory analysis has core refractive index of 1.5 and cladding refractive index of 1.47. Determine: the critical angle at core cladding interface the NA of the fiber the acceptance angle in air for the fiber
Q. 7	Write Short notes on:

	Modes of Propagation in optical fibers Ray theory transmission Attenuation in optical fibres Intra modal dispersion.
Q. 8	A p-i-n photodiode on average generates one electron hole pair per three incident photons at a wavelength of 0.8μm. Assuming all the electrons are collected, calculate: The quantum efficiency of the device Its maximum possible bandgap energy The mean output photocurrent when received optical power is 10^-7 W
Q. 9	Explain the basic principle of operation of LASER with neat diagram
Q. 10	Draw the schematic and energy band diagram of double hetero-junctions LED and explain the operation. State why it is more efficient in its action than homo-junctions.
Q. 11	Explain the various optical transmitters–LED drive circuits for digital transmission
Q. 12	Explain the conditions necessary to attain lasing action in LASERs. Also state the advantages of LASER over LED.
Q. 13	Explain the working of PIN photo detector with relevant diagrams
Q. 14	Compare p-i-n, APD and photo transistors
	HOT*
Q.15	What is the difference between an optical photon and an acoustic phonon?
Q.16	Calculate the number of photons, from green light of mercury (ʎ = 4961 Å), required to do one joule of work. a) 4524.2×1018/m3 b) 2.4961×1018/m3 c) 2.4961/m3

	d) 2.4961/m JUSTIFY Your Answer
Q.17	Consider a single mode fiber having core refractive index n1= 1.5. The fiber length is 12m. Find the time taken by the axial ray to travel along the fiber a) 1.00μsec b) 0.06μsec c) 0.90μsec d) 0.30μsec. Justify your answer.

Oral Question Bank: UNIT I

CO1(1.4.1-3, 2.2.4-3, 2.3.1- 2)

Q. 1	What are the advantages of Optical communication?
Q. 2	Compare Optical communication with satellite communication.
Q. 3	Compare step index fiber with graded index fiber
Q. 4	What is the difference between single mode step index fiber and multimode step index fiber?
Q. 5	What do you mean by dispersion? Explain bandwidth length product for optical communication?
Q. 6	What do you mean V-number? What is the cut off wavelength?
Q. 7	What is Numerical Aperture? What is the condition for Total Internal Reflection (TIR)?
Q. 8	What is the wavelength range for optical communication? Explain six spectral bands for optical communication?
Q. 9	What is bending loss? Explain types of bending loss.
Q. 10	What is the difference between LED and LASER?
Q. 11	What are the types of LED? Which is most suitable for optical communication?

Q. 12	What do you mean by internal quantum efficiency?
Q. 13	What are requirements of receiver in optical communication?
Q. 14	What do you mean by quantum efficiency for photodetector?
Q.15	What do you mean by responsivity?

2.8 b. Unit No.-II

Pre-requisites:-

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Basic Communication System	Basic Electronics Engineering	F.E.
2	Selection of Transmitter, Receiver	Electronic System Design	T.E.

Objectives:-

1. To introduce the concept of WDM and explain issues related to system design with special emphasis on power budget and rise time budget.

Outcomes:-

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

CO2: Estimate Power and Rise Time Budgets for a typical fibre optic link.

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	System Architectures	R1:5.1	**CO2**

2	Point-to-Point Links: System Considerations	T1:8.1, 8.1.1	1.4.1 -3 2.1.2-3
3	Design Guidelines: Optical Power Budget, Rise Time Budget	R1:5.2.3, 5.2.4	2.3.2-3 4.3.2-3
4	Long-Haul Systems.	R1:5.3.2,5.3.3	4.3.3-3

Question Bank: UNIT II

Theory Questions-CO2 (1.4.1 -3, 2.1.2-3, 2.3.2-3, 4.3.2-3, 4.3.3-3)

Q. 1	Explain in detail the importance of budgets. What are the different system considerations for rise time budget?
Q. 2	The 10-90% rise time s for possible components to be used in D-IM analog optical fiber link are specified below: Source (LED) 10ns; Fiber cable: intermodal 9ns/km; Intramodal: 2ns/km ; Detector(APD): 3ns. The desired link length without repeaters is 6km and the required optical bandwidth is 6MHz. Determine whether the above combination of components give an adequate temporal response.
Q. 3	Write Short notes on: Rise time Budget Link Power Budget
Q. 4	An analog optical fiber system is operating at a wavelength of 1.3µm has a post detection bandwidth of 5MHz. Assuming an ideal detector and considering only quantum noise on the signal, calculate the incident power necessary to achieve an SNR of 50 dB at the receiver.

Q. 5	Components chosen for a digital optical fiber link of overall length 10km and operating at 20Mbits/s using an RZ code are given Below: LED capable of launching a average power of 0.1mW at 0.85µm [incl. connector loss into a 50µm core diameter graded index fiber] Fiber attenuation 2.5 dB/km Requires splicing every 2km with a loss of 0.3dB per splice. There is also a connector loss at the receiver of 1.5dB The receiver requires mean incident optical power of -46dBm in order to give the necessary BER of 10^-10 Predicted safety margin of 6Db Write down the optical power budget for the system and determine it viability.
Q. 6	An optical fiber system is to be designed to operate an 8km length without repeaters. The rise times of the chosen components are Source(LED): 8ns Fiber cable : Intermodal:5ns/km Intramodal :1ns/km Detector(PIN) :6ns Estimate maximum bit rate that may be achieved on the linked when using NRZ and RZ format.
Q. 7	Write a short note on: 1)Broadcast network 2) Telephone access network
	HOT*
Q.8	**How optical power budget is affected by bit rate??**
Q.9	**What is the relation between through put, SINR and Spectral efficiency?**

Oral Question Bank: UNIT II

<u>CO2</u> (1.4.1 -3, 2.1.2-3, 2.3.2-3, 4.3.2-3, 4.3.3-3)

Q. 1	Explain key elements of Optical communication.
Q. 2	What do you mean by point to point link?

Q. 3	What are the selection criteria for optical source?
Q. 4	What are the selection criteria for optical detector?
Q. 5	What are the selection criteria for optical fiber?
Q. 6	Explain link power budget with example.
Q. 7	What do you mean by System Margin? What is the standard value for System Margin?
Q. 8	Compare Analog link and Digital link.
Q. 9	What do you mean by Rise time budget?
Q. 10	Explain multichannel techniques.
Q. 11	What do you mean by Carrier to Noise ratio?
Q. 12	What is the bit rate for NRZ and RZ format?

2.8 c. Unit No.-III

Pre-requisites:-

Sr.No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Concept of amplifier	Basic Electronics Engineering	F.E.
2	Concept of Multiplexer and De-multiplexer	Digital Electronics	S.E.
3	Basics of TDM, FDM	Analog Communication	T.E.

Objectives:-

To introduce the concept of WDM and WDM components

To familiarise students with optical amplifiers

Outcomes:-

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

CO3: Explain the basic working principle of WDM and its components and Optical amplifier.

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Overview of WDM	T1 :10.1	**CO3** 1.4.1 –3 2.1.2-3
2	WDM Components: 2 x 2 Fiber Coupler, Optical Isolators and Circulators	T1 : 10.2.1	
3	Multiplexers and De-multiplexers	R1: 10.3, T1 : 10.4.1	
4	Fiber Bragg Grating, FBG applications for multiplexing and De-multiplexing function.	T1 : 8.2.2, 10.4.3	
5	Diffraction Gratings	T1 : 10.4.3	
6	Overview of Optical Amplifiers: SOA, EDFA and RFA in brief.	R1 : 6.1 , 6.1.1, 6.1.2,6.1.3	

Question Bank: UNIT III

Theory Questions-CO3

(1.4.1 –3, 2.1.2-3)

Q. 1	Write Short notes on: 1.2*2 Coupler 2.Isolator 3.Circulator 4. EDFA
Q. 2	Draw neat diagrams of SOA and EDFA. Also compare them
Q. 3	Write short note on WDM couplers and explain its excess loss, Insertion Loss coupling ratio, Isolation and Uniformity properties.

Q. 4	Explain WDM in detail. Also mention the advantages and disadvantages of WDM.
Q. 5	Explain FBG in detail. Also explain diffraction gratings.
Q. 6	Explain WDM as a multiplexer.
Q. 7	Consider an EDFA with a gain of 26dB and a max power o/p of 0dBm. Compare the o/p signal levels per channel for 1, 2, 4 and 8 wavelength channels, where the input power is 1μW for each signal. What are the output levels per channel in each case if the pump power is double.
Q. 8	Explain important features of WDM architecture.
Q. 9	What is the necessity of DWDM?
Q.10	Explain the working of Optical Isolator.
Q. 11	Explain the working of AWG.
	HOT*
Q.12	**An SOA has net gain coefficient of 300, at a gain of 30dB. Determine length of SOA.** **a) 0.32 m b) 0.023 m c) 0.245 m d) 0.563 m**
Q.13	**_____is superior as compared to _** **a) TWA, FPAb) FPA, TWAc) EDFA, FPA d) FPA, EDFA**

Oral Question Bank: UNIT III

CO3(1.4.1 –3, 2.1.2-3)

Q. 1	What is WDM? What are types of WDM?
Q. 2	Give features of WDM.
Q. 3	What do you mean by insertion loss and excess loss?
Q. 4	What do you mean by Coupling or Splitting ratio?
Q. 5	What do you mean by Coupler and Isolator?
Q. 6	Explain basic principle of Circultaor? Also give any one of the application Circulator.

Q. 7	What do you mean by Cross talk?
Q.8	What is Optical Amplifier? What are the types of Optical Amplifier?
Q.9	Explain basic principle of EDFA.
Q.10	Explain basic principle of SOA

2.8 d. Unit No.-IV

Pre-requisites:-

Sr.No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Basic mechanism of satellite communication	Basic Electronics Engineering	F.E.

Objectives:-

1. To familiarize students with the basics of orbital mechanics and the basic satellite communication system

Outcomes:-

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

CO 4: Describe Key components, various satellite subsystems and Orbital effects in Satellite Communication Systems.

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Brief History	T2, section 1.2 ; Pp 3-5	**CO4**

2	Orbital mechanics.	T2, Section 2.1 , pp17-20	1.4.1-3 2.2.4-3 2.3.1- 3
3	Kepler's law for planetary motion	T2, Pp22-23	
4	Look Angles(LA)	T2, Section 2.2, Pp30-32	
5	Elevation angle El, Azimuth Angle Az, Determination of Las for GEOs	R2,Section 3.1,3.2 ; pp 67-74	
6	Satellite visibility considerations	R2, Section 3.4; Pp77-79	
7	Orbital perturbations	R2, Section 2.3 ; Pp 38-43	
8	Launches and Launch vehicles	R2, section 2.5; pp 43-49	
9	Orbital effects Communication system performance	R2, section 2.6 ; Pp 49-54	

Question Bank: UNIT IV

Theory Questions-CO4

(1.4.1-3, 2.2.4-3, 2.3.1- 3)

Q. 1	Explain with block diagram basics of satellite communication system.
Q. 2	State and explain Kepler's three laws of planetary motion. Explain the forces associated with it.
Q. 3	What is Look angles composed of? What is sub-satellite point?

Q. 4	What does LEO, MEO and GEO orbits mean by? State specific applications of each. What is the difference between Geo Stationary and Geo Synchronous Satellite? How many satellites are there in GEO orbit at present and what is their placing in distance (and in angles from earth)
Q. 5	Derive the equation for computing Elevation angle and Azimuth angle for an earth station – GEO satellite arrangement.
Q. 6	How does a solar eclipse affect a communications satellite?
Q. 7	Derive the equation which tells that a satellite is visible from an earth station
Q. 8	Based on different hemisphere and physical locations, explain how to compute Azimuth angle (Az) from intermediate angle α.
Q. 9	Derive expression for period of satellite orbit in terms of radius of orbit
Q.10	Explain the following orbitals effects Doppler Shift Solar Eclipse
Q.11	Explain the following terms: i) Apogee ii) Perigee iii) Eccentricity iv) Semi major Axis v) Semi minor Axis vi) Right Ascension of ascending node vii) Mean Anomaly
	HOT*
Q.12	**A satellite downlink at 12GHZ operates with a transmit power of 6w & an antenna gain of 48.2db. Calculate the EIRP in dBw.** **(a) 56dBw (b) 16dBw (c) 56dB (d) None of above**
Q.13	**An antenna has a noise temperature of 35k & its matched into a receiver which has a noise temp of 100k. Calculate the noise power density.** **(a) 1.86*10-21J (b) 1.6*10-25J (c) 186*10-21J (d) None of above** **67. An antenna.**

Oral Question Bank: UNIT IV

CO4 (1.4.1-3, 2.2.4-3, 2.3.1- 3)

Q. 1	State Kepler's law? Explain first Law of planetary motion
Q. 2	What do mean by LEO, MEO, GEO?
Q. 3	What is the frequency range for Satellite communication?
Q. 4	Compare Geostationary orbit and Geosynchronous orbit.
Q. 5	What are the Key elements of Satellite Communication?
Q. 6	What is Apogee and Perigee?
Q. 7	What are the orbital elements in Satellite Communication?
Q.8	What is the condition for Visibility Test?
Q.9	What are the orbital effects in Satellite Communication System performance
Q.10	State Look angle and Azimuth angle.

2.8 e. Unit No.-V

Pre-requisites:-

Sr. No.	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Basic mechanism of satellite communication	Basic Electronics Engineering	F.E.

Objectives:-

1. To familiarise students with the basics of orbital mechanics and the basic satellite communication system

Outcomes:-

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

CO 4: Describe Key components, various satellite subsystems and Orbital effects in Satellite Communication Systems.

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Launchers and Launch Vehicle	T2,R2	**CO4**
2	Satellite Subsystems	T2, R2	1.4.1-3
3	Attitude and Control Systems (AOCS)	T2, R2	2.2.4-3
4	Telemetry, Tracking	T2, R2	2.3.1-3
5	Commanded and Monitoring Power Systems	T2, R2	
6	Types of Antennas	T2, R2	
7	Equipment Reliability and Space Qualification	T2, R2	

Question Bank: UNIT V

Theory Questions-CO4

(1.4.1-3, 2.2.4-3, 2.3.1- 3)

Q. 1	With the help of block diagram, explain typical tracking, telemetry, command and monitoring system
Q. 2	Explain the transponder arrangement and frequency plan (uplink and downlink) for any satellite. Also draw block diagram of single conversion
Q. 3	What are different types of antennas used in satellite systems, explain importance of each.
Q. 4	Write short notes on Attitude and orbit control systems. Tracking, telemetry, command and monitoring systems Equipment lifetime and space qualification.

Q. 5	Explain the following terms and hence explain their significance in Satellite Communication G/T ratio for the Earth station and antenna noise temperature for the Earth station antenna
Q. 6	List the important features of TTC and M system
Q. 7	Explain the functioning of command subsystem
Q. 8	Write a short note on power systems used in satellite
Q. 9	Write a short note on equipment reliability and space qualifications.
Q.10	Explain typical transponder arrangement used in satellite
	HOT*
Q.11	**Which of the following is not a part of the propulsion subsystem of a satellite?** **a)Gyroscope b) Jet thruster c)AKM d) Fuel control system**
Q.12	**Why is there a huge spectrum space between the transmitted and received signal in satellite communication?** **a) Reduce interference b) Maximum efficiency** **c) Less attenuation d) To reduce space occupied by filters**

Oral Question Bank: UNIT V

<u>CO4</u>(1.4.1-3, 2.2.4-3, 2.3.1- 3)

Q. 1	Draw diagram for TTC in Satellite Communication.
Q. 2	What are the characteristics of Satellite Communication Subsystem?
Q. 3	What are the elements of Satellite Communication Subsystem?
Q. 4	What are the types of Satellite Antennas?
Q. 5	What do you mean by Directivity and Directivity Gain?
Q. 6	What is the Antenna efficiency?
Q. 7	What is effect Aperture?
Q.8	Explain Attitude and Control System (AOCS).

Q.9	Explain Satellite Subsystem.
Q.10	What are the functions of Satellite Communication System?

5.8 f. Unit No.-VI

Pre-requisites:-

Unit	Broad Topic to be covered	Linkage with previous subjects in the curriculum	Year
1	Basic mechanism of satellite communication	Basic Electronics Engineering	F.E.
2	Concept of system designing	Electronic System Design	T.E.

Objectives:-

1. To explain satellite link design for uplink and down link

Outcomes:-

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

CO5: Estimate satellite link budget for up-link, down-link, and overall link and Analyze orbital mechanics, calculation of antenna look angles, C/N and G/T computations .

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Design of Downlinks	T2, R2	**CO5** 2.1.2-3
2	Satellite system using small Earth Stations	T2, R2	
3	Steps for uplink design	T2, R2	

4	Design specified C/N: Combining C/N and C/I values in satellite link design	T2, R2	2.1.2-3 4.3.2-3
5	System Design Examples	T2, R2	4.3.3-3

Question Bank: UNIT VI

Theory Questions-CO5 (2.1.2-3, 2.1.2-3, 4.3.2-3, 4.3.3-3)

Q. 1	Explain basic transmission theory of satellite communication link design.
Q. 2	What do you mean by EIRP?
Q. 3	In relation to satellite communication, define noise temperature and derive the equation for carrier to noise ratio at the output of demodulator.
Q. 4	Explain system noise temperature and G/T ratio.
Q. 5	Explain design parameters of uplink and downlink systems.
Q. 6	Obtain the expression of C/N in terms of system temperature.
Q. 7	Derive the link equation for satellite communication
Q. 8	Explain satellite systems using small earth stations.
Q. 9	Explain various losses in downlink analysis.
Q.10	Derive and expression for inverse square law.

Oral Question Bank: UNIT VI

CO5 (2.1.2-3, 2.1.2-3, 4.3.2-3, 4.3.3-3)

Q. 1	What do you mean by EIRP?
Q. 2	What do you mean by noise spectral density?
Q. 3	What is G/T ratio?

Q. 4	Give the steps for Uplink design.
Q. 5	Give the steps for downlink design.
Q. 6	Give steps for overall link design in satellite communication.
Q. 7	What is path loss? What is the equation for path loss?
Q.8	What is the equation for received power?
Q.9	What are the total losses considered while designing the satellite link budget?
Q.10	What is noise figure and noise temperature in satellite communication?

2.9 List of Experiments

Course Outcome:

CO6: Improve written, oral, and presentation communication skills related to the subject of Broadband Communication Systems and engage in a life-long learning**.**

Sr. No.	Name of the Experiment	CO Addressed
1	To estimate the Numerical Aperture (N.A) of the given fiber.	CO1 1.4.1-3 2.2.2-3 2.4.2-3
2	To study analog and digital link in an optical fiber communication system	CO2 2.1.1- 3 2.1.2- 3
3	To plot the characteristics of various sources.	CO1 1.4.1-3

		2.2.2-3 2.4.2-3
4	To measure attenuation of MMSI and SMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend.	CO1 1.4.1-3 2.2.2-3 2.4.2-3
5	To plot the characteristics of various detectors.	CO1 1.4.1-3 2.2.2-3 2.4.2-3
6	Tutorial on Power budget and rise time budget analysis of optical fiber system.	CO3 2.1.2-3 2.3.2-3 2.4.2-3 3.2.2-3
7	To establish a direct communication link between Uplink Transmitter and Downlink Receiver using tone signal.	CO2 2.1.1- 3 2.1.2- 3
8	To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver.	CO2 2.1.1- 3 2.1.2- 3
9	Tutorial on satellite link design.	CO3 2.1.2-3 2.3.2-3

		2.4.2-3 3.2.2-3
10	To measure the electrical bandwidth and optical bandwidth .Also compare it.	CO1 1.4.1-3 2.2.2-3 2.4.2-3
11	To study and find out the losses across the optical fiber link by using OTDR.	CO1 1.4.1-3 2.2.2-3 2.4.2-3

3.Name of the Course –Machine Learning (4041910) (Elective III)

Weekly Work Load (in Hrs)	Lecture	Tutorial	Practical
	3	-	2

Online/ In-sem	Theory	Practical (Lab practice IV)	Oral	Term-work (Lab practice IV)	Total Marks	Credit
30	70		50		150	4(3+1)

3.1 Syllabus

Unit I: Introduction to Machine Learning **4 Hrs**

Why Machine learning. Types of machine learning, basic concepts in machine learning like Parametric and non-parametric modeling, linear and nonlinear regression, over fitting and Dimensionality reduction. Decision trees, Feature reduction

Unit II: Models for Regression and Classification **8Hrs**

Linear Models for Regression :Least Squares and Nearest Neighbors ,Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison Linear Models for Classification : Discriminant Functions .Probabilistic Discriminative Models Multivariate Data, Parameter Estimation, Multivariate Classification, Multivariate Regression Kernel Methods: Support Vector machines and Relevance Vector Machines

Unit III: Clustering **6Hrs**

Dimensionality Reduction: Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis Clustering: k-Means Clustering, Mixtures of Gaussians.

Unit IV: Artificial Neural Networks I **6Hrs**

Biological neuron, artificial neuron model, concept of bias and threshold, Activation functions, McCulloch-Pits Neuron Model, learning paradigms, concept of error energy, gradient descent Algorithm and application of linear neuron for linear regression: Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations.

Unit V: Artificial Neural Networks II **6 Hrs**

Multilayer perceptron (MLP) and back propagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps, Learning vector quantization Radial Basis Function networks.

Unit VI: Deep Learning and Convolution Neural Networks **6Hrs**

Improvement of the Deep Neural Network: Vanishing Gradient, Over fitting, Computational Load, ReLU Function, Dropout Architecture of ConvNet, Convolution Layer, Pooling Layer, Applications of CNN's.

3.2 Course Objectives

The objectives of **Machine Learning** are to:

- **To introduce** basic concepts in Machine Learning and types of Machine Learning (Unit I)
- **To explain** models for regression and classification (Unit II)
- **To discuss** dimensionality reduction and clustering algorithms. (Unit III)
- **To elaborate** Artificial Neural Networks (Unit IV and V)
- **To explain** Deep Learning and Convolutional Neural Networks (Unit VI)

3.3 Course Outcomes

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

1. Explain basic concepts in Machine Learning and its types. (BT Level-2, Understand) (Unit I)
2. Apply regression and classification techniques to supervised learning problems. (BTL-3, (Apply) (Unit II)
3. Illustrate dimensionality reduction and Clustering algorithms. (BTL-3, Apply) (Unit III)
4. Use Artificial Neural Networks for Classification. (BTL-3, Apply) (Unit IV and V)
5. Explain Deep Learning and Convolutional Neural Networks. (BTL-2, Understand) (Unit VI)

3.4 Text Books:

1. Christopher Bishop, ―Pattern Recognition and Machine Learning‖, Springer, 2007.

2. LaureneFausett ,‖ Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education, Inc, 2008.

3.5 Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, ―The Elements of Statistical Learning‖, Springer 2009.

3. Phil Kim, ―MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence ‖,a Press 2017.

4. EthemAlpaydın ―Introduction to Machine Learning Second Edition The MIT Press 2010.

5. Simon Haykin, Neural Networks : A comprehensive foundation, Prentice Hall International Inc. 1999.

3.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

https://onlinecourses.nptel.ac.in/noc20_cs29/

The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman (freely available online)

3.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	Book Referred	Total Lecture Planned	CO Addressed
1.	I	Introduction to Machine Learning	T1, R1, R4	4	**CO1,** 1.1.1- 3, 1.1.2- 3 2.1.2-3, 2.1.3-3 2.4.1-3
2.	II	Models for Regression and Classification	T1, R1, R2	8	**CO2** 1.1.1-3, 1.1.2 -3 2.1.2-3, 2.1.3-3 2.4.1-3
3.	III	Clustering	T1, R2, R4	6	**CO3** 1.1.1-3, 1.1.2 -3 2.1.2-3, 2.1.3-3 2.4.1-3
4.	IV	Artificial Neural Networks I	T2, R3, R5	6	**CO4** 1.1.1-3, 1.1.2 -3 1.2.1-1, 2.1.2-3 2.1.3-3, 2.4.1-3
5.	V	Artificial Neural Networks II	T2, R3, R5	6	**CO4** 1.1.1-3, 1.1.2 -3 1.2.1-1, 2.1.2-3 2.1.3-3,2.4.1-3

6.	VI	Deep Learning and Convolution Neural Networks	T2, R3, R5	6	**CO5** 1.1.1-3,1.1.2 -3 2.1.2-3,2.1.3-3 2.4.1-3

3.8 Unit wise Lecture Plan

3.8 a. Unit No.-I

Pre-requisites:- Artificial Intelligence

Objectives: To introduce basic concepts in Machine Learning and types of Machine Learning.

Outcomes: Explain basic concepts in Machine Learning and its types.

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Why Machine learning. Types of machine learning,	T1, R1, R4	**CO1**
2	Basic concepts in machine learning like Parametric and non-parametric modeling,	T1, R1, R4	
3	linear and nonlinear regression	T1, R1, R4	
4	Over fitting and Dimensionality reduction. Decision trees, Feature reduction	T1, R1, R4	

Question Bank: Theory

<u>Theory Questions-CO1</u> (PI: 1.1.1- 3, 1.1.2- 3, 2.1.2-3, 2.1.3-3, and 2.4.1-3)

Q. 1	What is Machine learning?
Q. 2	What are the types of Machine learning?

Q. 3	What is Parametric and non-parametric modeling?

Q. 4	What are the goals of Machine Learning?

Q. 5	Explain Decision Tree algorithm with example.

Q. 6	What do you mean by linear and nonlinear regression?

Q. 7	Describe Parametric and non-parametric learning with their advantages and limitations. State any four applications where machine learning is used?

Q. 8	What is over fitting in machine learning? Describe in brief.

Q.9	List various algorithms used in Machine Learning with their use cases
Q.10	Define Following: 1. Dependent Variable 2. Independent Variable 3. Outlier

HOTS

Q. 11	With suitable example, describe how linear Regression is used to predict the output for test example/input sample.
Q. 12	What are the different methods to overcome the over fitting problem.

3.8 b: Unit No.-II: Models for Regression and Classification

Pre-requisites:- basic concepts of machine learning

Objectives: - To explain models for regression and classification.

Outcomes: Apply regression and classification techniques to supervised learning problems. (BTL-3, Apply) (Unit II)

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Linear Models for Regression :Least Squares Regression	T1, R1, R2	**CO2**
2	Nearest Neighbors, Linear Basis Function Models,		
3	The Bias-Variance Decomposition,	T1, R1, R2	
4	Bayesian Linear Regression, Bayesian Model Comparison Linear Models for Classification: Discriminant Functions.	T1, R1, R2	
5	Probabilistic Discriminative Models Multivariate Data,	T1, R1, R2	
6	Parameter Estimation, Multivariate Classification,	T1, R1, R2	
7	Multivariate Regression Kernel Methods : Support Vector machines and Relevance Vector Machines	T1, R1, R2	
8	K-NN, Naïve Bayes	T1, R1, R2	

Question Bank:

<u>Theory Questions</u> – CO2 (PI: 1.1.1-3, 1.1.2 -3, 2.1.2-3, 2.1.3-3, and 2.4.1-3)

Q. 1	Explain the use of KNN algorithm for regression.

Q. 2	Which are the various Methods of the calculating distance between neighboring points?
Q. 3	Which are the different sources that cause error in output of machine learning models?
Q. 4	Explain Univariate, bivariate and multivariate data.
Q. 5	Explain the advantages and disadvantages of Multivariate Regression
Q. 6	Describe Bayesian Regression.
Q. 7	Explain Support Vector Machine as a Classifier.
Q.8	Explain Bias-Variance Trade off in Machine Learning.
Q.9	Using the method of Least Square: Find an equation of the form y= ax + b that fits the following data:

x	1	2	3	4	5	6	7	8	9	10
y	10	22	33	40	56	62	68	78	90	102

	***HOTs**
Q.10	Which applications are best modeled by linear regression?

Q.11	What do you mean by linearly separable data and non-linearly separable data?

3.8 c. Unit No.-III Clustering

Pre-requisites:- basic concepts of machine learning

- **Objectives: -** To explain models for regression and classification
- **Outcomes: -** Illustrate dimensionality reduction and clustering algorithms. (BTL-3, Apply) (Unit III)

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Dimensionality Reduction: Principal Components Analysis,	T1, R2, R4	**CO3**
2	Principal Components Analysis,	T1, R2, R4	
3	Factor Analysis, Multidimensional Scaling,	T1, R2, R4	
4	Linear Discriminant Analysis	T1, R2, R4	
5	Clustering : k-Means Clustering,	T1, R2, R4	
6	Mixtures of Gaussians	T1, R2, R4	

Question Bank: Theory

<u>Theory Questions</u> –CO3 (PI: 1.1.1-3, 1.1.2 -3, 2.1.2-3, 2.1.3-3, and 2.4.1-3)

Q. 1	What does dimensionality reduction mean? Explain its importance.
Q. 2	Compare and contrast between Principal Component Analysis and Linear Discriminant Analysis:
Q. 3	How does the K-Means Algorithm Work? Explain in suitable steps.

Q. 4	Explain in brief the feature selection and discuss in details any suitable feature selection method.

Q. 5	Write short note on 1. Principal Component Analysis 2. Factor Analysis and its Application
	***HOTs**
Q.6	Justify the following i) Predict the height of a person. Is it a regression task? ii) Find the gender of a person by analyzing his writing style. Is it a classification task? iii) Filter out spam emails. Is it an example of unsupervised learning
Q.7.	How to find out the ideal value of the final K in k-means clustering?

3.8 d. Unit No.-IV

Pre-requisites:- basic concepts of machine learning

Objectives: - To elaborate Artificial Neural Networks

Outcomes: Use Artificial Neural Networks for Classification. (BTL-3, Apply) (Unit IV and V)

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Biological neuron, Artificial neuron model,.	T2, R3, R5	CO4
2	concept of bias and threshold, Activation functions,		
3	McCulloch-Pits Neuron Model,		

4	learning paradigms, concept of error energy,		
5	gradient descent algorithm and application of linear neuron for linear regression,:		
6	Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations		

Question Bank: Theory

Theory Paper-CO3 (PI: 1.1.1-3, 1.1.2 -3, 2.1.2-3, 2.1.3-3, and 2.4.1-3)

Q. 1	Define ANN and Neural computing.
Q. 2	Mention the characteristics of problems suitable for ANNs.
Q. 3	List some applications of ANNs..
Q. 4	What are the design parameters of ANN?
Q. 5	Write the advantages and disadvantages of Artificial Neural Networks.
Q. 6	Draw the model of MP (McCulloch Pitts) neuron and state its characteristics.
Q. 7	Develop simple ANNs to implement the three input AND, OR and XOR functions using MP neurons.
Q. 8	Define Hebbian Synapse
Q. 9	What is gradient descent?

Q.10	Explain what is a loss function and its types
	***HOTs**
Q.11	List and explain the various activation functions used in ANN
Q.12	State the limitations of single layer Perceptron in computing the logical functions. Suggest an alternative network to overcome the above limitations

3.8 e. Unit No.-V

Pre-requisites:- basic concepts of machine learning

Objectives: - To elaborate Artificial Neural Networks

Outcomes:- Use Artificial Neural Networks for Classification. (BTL-3, Apply) (Unit IV and V)

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Multilayer perceptron (MLP)	T2, R3, R5	**CO4**
2	back propagation algorithm,		
3	back propagation algorithm		
4	Application of MLP for classification,		
5	Self-Organizing Feature Maps,		
6	Learning vector quantization Radial Basis Function networks		

Question Bank: Theory

<u>Theory Paper</u>–CO4 (PI: 1.1.1-3, 1.1.2 -3, 1.2.1-1, 2.1.2-3, 2.1.3-3, 2.4.1-3)

Q. 1	Explain what is a Multi-layer Perceptron (MLP)?

Q. 2	Explain what is the role of activation functions in a neural network?
Q. 3	What is Back propagation?
Q. 4	Explain the SOM algorithm
Q. 5	Why do we need Optimizers for Neural Network?
Q. 6	How does Gradient Descent get stuck at the local minima?
Q. 7	Explain various Neural Network Learning Rules
Q.8	Explain Radial Basis Function networks
	***HOTs**
Q.9	What is the significance of error in back propagation?
Q.10	What are the three learning phases of Radial Basis Function networks

3.8 f. Unit No.-VI

Pre-requisites:- basic concepts of machine learning

Objectives:- To explain Deep Learning and Convolutional Neural Networks (Unit VI)

Outcomes:- Explain Deep Learning and Convolutional Neural Networks.(BTL-2, Understand) (Unit VI)

Sr. No.	Details of the Topic to be covered	References	CO Addressed
1	Improvement of the Deep Neural Network: Vanishing Gradient,.	T2, R3, R5	**CO5**
2	Over fitting, Computational Load,		
3	ReLU Function, Dropout		
4	Architecture of ConvNet,		
5	Convolution Layer, Pooling Layer,		
6	Applications of CNN's		

Question Bank: Theory

Theory QUESTIONS–CO5 (PI: 1.1.1-3, 1.1.2 -3, 2.1.2-3, 2.1.3-3, 2.4.1-3)

Q. 1	Explain what is Exploding and Vanishing Gradient?
Q. 2	Explain ReLU and Softmax functions.
Q. 3	What Is the Difference Between a Feed forward Neural Network and Recurrent Neural Network?
Q. 4	What Are the Applications of a Recurrent Neural Network (RNN)?
Q. 5	What Are Hyper parameters?
Q. 6	What is Pooling on CNN, and How Does It Work?
Q. 7	Draw and explain Architecture of ConvNet,

Q. 8	Explain various Applications of CNN's

	***HOT**
Q.9	Explain Generalization.
Q.10	Why do we prefer Convolutional Neural networks (CNN) over Artificial Neural networks (ANN) for image data as input?

3.9 List of Practical

The objectives of Lab Practice-IV are:

- To demonstrate neural networks for various applications. (Exp 1, 2, 4, 5)
- To describe MLP with back propagation (EXP 3)
- To discuss classification using SVM algorithm. (Exp 6,7)
- To demonstrate object recognition using CNN model (Exp 8)

On completion of the course, student will be able to

- Implement neural networks for various applications (Exp 1, 2, 4, 5) (BTL:3, Apply)
- Implement Multilayer Perceptron (MLP) with back propagation (Exp 3) (BTL:3, Apply)
- Use SVM algorithm for classification. (Exp 6,7) (BTL:3, Apply)
- Demonstrate object recognition using CNN model (Exp 8) (BTL:3, Apply)

List of Experiments:

Sr. No.	Name of Experiment	CO Addressed
1	Implement simple logic network using MP neuron model	**CO1** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
2	Implement a simple linear regressor with a single neuron model	**CO1**

		(2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
3	Implement and test MLP trained with back-propagation algorithm	**CO2** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
4	Implement and test RBF network	**CO1** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
5	Implement SOFM for character recognition.	**CO1** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
6.	Implement SVM classifier for classification of data into two classes. Student can use datasets such as flower classification etc.	**CO3** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
7.	Implement and test Multiclass SVM classifier.	**CO3** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
8.	Implement and test CNN for object recognition.	**CO4** (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)

Oral Questions

Sr. No.	Name of Experiment	CO Addressed
1	Implement simple logic network using MP neuron model	CO1 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. What is ML? What is the need of ML 2. Explain four example of machine learning 3. Types of ML with examples.(Supervised and Unsupervised) 4. What is classification 5. What is the concept of MP neuron?	
2	Implement a simple linear regressor with a single neuron model	CO1 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. What is Regression? 2. Which are the Common classes of problems in Machine Learning? 3. What are the disadvantage of non-parametric machine learning algorithms? 4. What are the limitations of Parametric Machine Learning Algorithms? 5. What are the different methods to overcome the over fitting problem?	
3	Implement and test MLP trained with back-propagation algorithm	CO2 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
4	Implement and test RBF network	CO1 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. What are the advantage of RBF neural network? 2. What are the two processes involved in RBF network design?	

	3. How are radial basis functions useful in neural networks? 4. How many weights should be trained in a radial basis function network? 5. What is the activation function used in radial basis function network?	
5	Implement SOFM for character recognition.	CO1 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. What is an example of Self-Organizing Maps? 2. What are the five stages in self Organizing map? 3. What is the usage of self-organized feature map? 4. How many layers are there in self organizing feature map? 5. What are the applications of SOM?	
6.	Implement SVM classifier for classification of data into two classes. Student can use datasets such as flower classification etc.	CO3 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. What is SVM classifier used for? 2. What type of classifier is SVM? 3. Why SVM is used in machine learning? 4. What kernel is used in SVM? 5. Is SVM a binary classifier?	
7.	Implement and test Multiclass SVM classifier.	CO3 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)
	1. Why is SVM effective on high-dimensional data? 2. How do you reduce overfitting in SVM classifier? 3. What is margin in SVM? 4. What is multiclass SVM? 5. What is the regularization parameter in SVM?	
8.	Implement and test CNN for object recognition.	CO4 (2.1.2-3, 2.1.3-3, 2.4.2-3, 5.1.1-2, 5.1.2-3, 5.2.2-3)

	1. What do you mean by Convolutional Neural Network? 2. Why do we prefer Convolutional Neural networks (CNN) over Artificial Neural networks (ANN) for image data as input? 3. Explain the different layers in CNN 4. Explain the significance of the RELU Activation function in Convolution Neural Network 5. What is object recognition?	

4.Name of the Subject – ROBOTICS (404192) (Elective-IV)

Weekly Workload (in Hrs.)	Lecture	Tutorial	Practical
	3	-	-

Online/ In-sem.	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70		-	-	100	3

4.1 Syllabus

Unit I : Basic concepts in robotics 6Hrs
Definition, anatomy of robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics, Industrial Applications of Robots.

Unit II :Robot drivers, Sensors and Vision 6Hrs
Drives for robots: Electric, hydraulic and pneumatic. Sensors: Internal-External, Contact, non-contact, position, velocity, force, torque, proximity and range. Vision: Introduction to techniques, Image acquisition and processing.

Unit III : End Effectors and Actuators 6Hrs
Different types of grippers- Mechanical, Magnetics, vacuum, Adhesive, Gripper force Analysis & Gripper Design , overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servo motors.

Unit IV : Robot Kinematics and Dynamics 8Hrs
Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Lagrangian formulation , Link inertia tensor and manipulator inertia tensor, Newton –Eller formulation for RP and RP manipulators, Trajectory planning, interpolation, static force and moment transformation, solvability, stiffness.

Unit V:Programming methods 6Hrs
Robot language classification, Robot language structure, elements and its functions. Simple programs on Sensing distance and direction., Line Following Algorithms, Feedback Systems Other topics on advanced robotic techniques.

Unit VI : Developing and building a robot 6Hrs
Models of flexible links and joints, Robotic arm – Components and structure, Types of joints and workspace, Design models for mechanical arms and lifting systems Case Study: 1. Robots in material handling and assembly. 2. Human Robot Interaction.

4.2 Course Objectives

- To **explain** the concepts, development and key components of robotics technology. (Unit 1)
- To **describe** the concepts of Drivers, Sensors, End Effectors and Actuators used in Robotics. (Unit II and III)
- To **explain** how to apply basic Kinematics and Dynamics required in Robotics with examples. (Unit IV)
- To **elaborate** different programming methods, development, and building of a robot. (Unit V and VI)

4.3 Course Outcomes

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

1. **Explain** the basic concepts, key components and development in robotics. (Unit 1) (BTL 2- Understand)
2. **Compare the working** of different Drivers, Sensors, End Effectors and Actuators used in Robotics. (Unit II and III) (BTL 4- Analyze)
3. **Solve** basic robot forward and inverse kinematic problems using mathematical manipulation of spatial coordinate representation and transformation. (Unit IV) (BTL 3- Apply)
4. **Apply** different programming methods for development and building a robot. (Unit V and VI) (BTL 3- Apply)

4.4 Reference Web Links/ Research Paper/ Referred Book other than mentioned in Syllabus:

www.acroname.com
www.lynxmotion.com
www.drrobot.com
Book- Introduction to Robotics by S.B.Niku , Eastern Economy Edition.

4.5 Teaching Plan

Overview of Teaching Plan

Unit	Broad Topics Covered	Total Lectures Planned	CO Addressed
1.	Basic concepts in robotics	6 Hrs	**CO1** 1.4.1, 2.1.2
2.	Robot drivers, Sensors and Vision	6 Hrs	**CO2** 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4
3.	End Effectors and Actuators	6 Hrs	**CO2** 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4
4.	Robot Kinematics and Dynamics	8 Hrs	**CO3** 2.1.3, 2.2.2
5.	Programming methods	6 Hrs	**CO4** 2.1.2, 2.2.2, 2.2.3, 2.2.4
6.	Developing and building a robot	6 Hrs	**CO4** 2.1.2, 2.2.2, 2.2.3, 2.2.4

Individual Hour wise plan:

Sr. No.	Unit	Topics to be covered
1	1	Definition, anatomy of robot
		basic structure of robot,
		Specifications and Classification of robots,
		Safety Measures in robotics,
		Industrial Applications of Robots.
		Industrial Applications of Robots.
2	2	Drives for robots introduction

	2	Electric, hydraulic and pneumatic.
		Electric, hydraulic and pneumatic.
		Sensors: Internal-External, Contact, non-contact,
		position, velocity, force, torque, proximity and range.
		Vision: Introduction to techniques, Image acquisition and processing.
3	3	Different types of grippers introduction.
		Mechanical, Magnetics, vacuum, Adhesive,
		Mechanical, Magnetics, vacuum, Adhesive,
		Gripper force Analysis & Gripper Design , overview of actuators,
		Power and torque, Acceleration and velocity Specifications and
		characteristics of Stepper motors, AC motors, DC motors and servo motors.
4	4	Direct and inverse kinematics for industrial robots for position and orientation,
		Redundancy, Manipulator, direct and inverse velocity.
		Lagrangian formulation, Link inertia tensor and manipulator inertia tensor,
		Newton –Euler formulation for RP and RP manipulators,
		Trajectory planning,
		interpolation, static force and moment transformation, solvability, stiffness.
		interpolation, static force and moment transformation, solvability, stiffness.
		interpolation, static force and moment transformation, solvability, stiffness.
5	5	Robot language classification,
		Robot language structure,
		elements and its functions.
		Simple programs on Sensing distance and direction.,
		Line Following Algorithms,

		Feedback Systems Other topics on advanced robotic techniques.
6	6	Models of flexible links and joints,
		Robotic arm – Components and structure,
		Types of joints and workspace,
		Design models for mechanical arms
		lifting systems Case Study: 1. Robots in material handling and assembly. 2. Human Robot Interaction.
		lifting systems Case Study: 1. Robots in material handling and assembly. 2. Human Robot Interaction.

4.6 Unit wise Lecture Plan

4.6 a Unit-I :Basic Concepts in Robotics (CO1)

Pre-requisites:- Mechatronics (TE semester I)

Objectives: To **explain** the concepts, development and key components of robotics technology. (Unit 1)

Outcomes: - After successfully completing the course students will be able to **Explain** the history, concept, development and key components of robotics technologies. (Unit 1) (BTL 2- Understand)

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Introduction of Robots, Definition, anatomy of robots.	T1, R2,	**CO1** 1.4.1, 2.1.2
2	Basic structure of robots.	T1, R2,	
3	Specifications and Classification of robots.	T1, R2, NPTEL Lecture Notes	
4	Specifications and Classification of robots.	T1, R2, NPTEL Lecture Notes	
5	Safety Measures in robotics.	T1, R2,	

6	Industrial Applications of Robots.	T1, R2,	

Question Bank: Theory (CO1-1.4.1, 2.1.2)

1. What are the 8 key components to every robot?
2. What is a robot and its uses?
3. What are the parts of a robot?
4. What were robots first used for?
5. What are the 3 main parts of a robot?
6. What are the 5 main components of a robot?
7. What kind of robots exist today?
8. What do robots do?
9. What is the main purpose of robots?
10. What are the main features of a robot?
11. Are the Three Laws of Robotics real?
12. What are the distinguishing characteristics of a robot?
13. What are the uses of a robot?
14. What is a manipulator in robotics?
15. What do industrial robots do?
16. What do industrial robots do?
17. Is the robotic end effector multifunctional?
18. How is a robot end effector specified?
19. How are robots programmed?
20. What do domestic robots do?
21. What do robots do in factories?
22. What are service robots used for?
23. What is robotics in manufacturing?
24. What makes a robot a mobile robot?
25. What makes a robot a robot?
26. What makes a robot autonomous?
27. What is a hybrid robot?
28. What is an industrial robot? State its applications in industry?

29. Sketch and explain various types of joints in manipulator mechanisms.
30. Sketch and explain 3 DOF associated with the wrist.
31. Explain the recent trends in industrial robots.
32. List a few safety precautions necessary for robotic application.
33. What are the three levels of safety sensor systems in robotics defined by National Bureau of Standards?
34. Explain the features of safety sensors & safety monitoring of robots.
35. Explain the different safety considerations for robot operations.

4.6 b. Unit-II

Robot Drivers, Sensors and Vision (CO-2)

Prerequisites:- Mechatronics (TE Sem-I)

Objectives: - To take overview of Drivers, Sensors, End Effectors and Actuators used in Robotics

Outcomes: - After successfully completing the course students will be able to **Analyze** working of different Drivers, Sensors, End Effectors and Actuators used in Robotics. (Unit II and III) (BTL 4-Analyze)

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Drives for robots: Electric, hydraulic and pneumatic.	T2, R2, NPTEL Lecture Notes	CO2 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4
2	Sensors: Internal-External, Contact, non-contact, position.	T2, R2	
3	Velocity sensors, force sensors, torque sensor.	T2, R2, NPTEL Lecture Notes	
4	Proximity sensors and Range finders.	T2, R2, NPTEL Lecture Notes	
5	Vision: Introduction to techniques, Image acquisition and processing.	T2, R2	
6	Vision: Introduction to techniques, Image acquisition and processing.	T2, R2	

Question Bank: Theory –(CO2 - 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4)

1. Discuss briefly the various kinds of sensors used in robotics.
2. Write short notes on photo-sensors.
3. Write a short note on different sensors for robot intelligence.
4. What do you mean by robot vision? Explain briefly.
5. Explain briefly "Vision hardware".
6. With the neat diagram explains the operation of the Ultrasonic range finder.
7. What are different types of vision sensors used in robotics? Explain any one of them with the help of a neat sketch.
8. Explain industrial applications of vision controlled robotics systems.
9. State the purpose of using potentiometer in displacement sensor?
10. What are the types of strain gauge?
11. What is Tacho-generator or Tachometer?
12. What are the instruments used to measure linear velocity?

1) Electromagnetic transducer 2) Digital transducer 3) Transducers with Doppler Effect.

13. Explain the function of a capacitive sensor in a robot end effectors?
14. Write short notes on (a) Thermocouple (b) Piezoelectric transducer (c) Incremental encoder (d) Photovoltaic transducer.

4.6 c. Unit-III

End Effectors and Actuators (CO-II)

Pre-requisites: - Mechatronics (TE Sem-I)

Objectives: - To take overview of Drivers, Sensors, End Effectors and Actuators used in Robotics.

Outcomes:- At the end of the course the Student will be able to **Analyze** working of different Drivers, Sensors, End Effectors and Actuators used in Robotics. (Unit II and III) (BTL 4- Analyze)

Lecture No.	Details of the Topic to be covered	References	CO Addressed

1	Different types of grippers- Mechanical, Magnetics.	T2, R1	**CO2** 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4
2	Different types of grippers- Vacuum, Adhesive	T2, R1	
3	Gripper force Analysis & Gripper Design.	T2, R1	
4	Overview of actuators, Power and torque.	T2, R1	
5	Acceleration and velocity Specifications of Actuators.	T2, R1	
6	Characteristics of Stepper motors, AC motors, DC motors and servo motors.	T2, R1	

Question Bank: Theory
Theory Paper (CO2- 1.2.1, 1.4.1, 2.1.3, 2.2.2, 2.2.4)

1. Discuss various considerations for selection of a gripper.
2. Explain vacuum grippers, with reference to the principle, use and applications.
3. State the comparison of the robot drive system with its advantages and limitations.
4. What are the features and application of "hydraulic actuators"?
5. Compare hydraulic and electrical actuators in robots.
6. Write a note on industrial robot control systems.
7. State the features of "pneumatic actuators".
8. Mention various components of the hydraulic system?
   a) Motor b) filter b) Pump d) pressure regulator c) Control valve.
9. What is a pneumatic system? Explain in detail with examples.
10. List the various components of a pneumatic system?
11. What is the purpose of using filters in a hydraulic system ?
12. List types of pneumatic control valves?
13. What are the features and application of "hydraulic actuators"?
14. Compare hydraulic and electrical actuators in robots.
15. State the features of "pneumatic actuators".

16. Which type of drive system is more suitable for heavy load robot application?
17. What is the end effector? Classify.
18. Compare pneumatic drive robots with stepper motor drive robots.
19. What is the difference between internal grippers and external grippers?
20. Classify robots according to the drive system.
21. List any TWO important advantages and disadvantages of a pneumatic gripper.
22. What is a mechanical gripper?
23. How will the sensor be evaluated?
24. Give some examples of tools as robot end effectors.
25. What are the types of hydraulic actuators?
26. What are the properties of a stepper motor?

4.6 d. Unit-IV

Robot Kinematics and Dynamics (CO-3)

Prerequisites:- Mechatronics (TE semester I)

Objectives: - To explain basic Kinematics and Dynamics required in Robotics with examples.

Outcomes: - At the end of the course the Student will be able to **solve** basic robot forward and inverse kinematic problems using mathematical manipulation of spatial coordinate representation and transformation. (Unit IV) (BTL 3- Apply)

Lecture No.	Details of the Topic to be Covered	References	CO Addressed
1	Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity.	T2 and R1	
2	Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity.	T2 and R1	**CO3** 2.1.3, 2.2.2
3	Lagrangian formulation , Link inertia tensor and manipulator inertia tensor.	T2 and R1	
4	Lagrangian formulation , Link inertia tensor and manipulator inertia tensor.	T2 and R1	

5	Newton –Euler formulation for RP and RP manipulators.	T2 and R1	
6	Trajectory planning, interpolation.	T2 and R1	
7	Static force and moment transformation, solvability, stiffness.	T2 and R1	
8	Static force and moment transformation, solvability, stiffness.	T2 and R1	

Question Bank: Theory (CO3 - 2.1.3, 2.2.2)

1. Define reverse kinematics.
2. List the different robot parameters.
3. What is inverse kinematics?
4. What is meant by Inverse kinematics of robots?
5. What is meant by a teach pendant?
6. Describe briefly the kinematics and dynamics of a robot.
7. Derive Euler method for PUMA Robot with Inverse Kinematics
8. Derive forward & inverse kinematics equations of manipulator for a particular position.
9. Write a critical note on forward and inverse kinematics of 3 degrees of freedom.
10. Discuss various difficulties associated with the inverse kinematic solution and explain the 'geometric approach' used in inverse kinematic problems.
11. List out the few robot applications areas in manufacturing.
12. Write a subroutine to calculate the inverse kinematics for the three-link manipulator. The routine should pass arguments.
13. Write a subroutine to compute the kinematics of a PUMA 560. Code for speed, trying to minimize the number of multiplications as much as possible. Use the procedure heading.
14. Write a main program that accepts a goal frame specified in terms of x, y, and This goal specification is (T} relative to {S}, which is the way the user wants to specify goals?

4.6 e. Unit-V

Programming methods (CO4)

Prerequisites:- Mechatronics (TE Semester I)

Objectives: - To teach different programming methods for development and building a robot.

Outcomes: - At the end of the course the Student will be able to **Apply** different programming methods for development and building a robot. (Unit V and VI) (BTL 3- Apply)

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Robot language classification, Robot language structure, elements and its functions.	T2 and R4	**CO4** 2.1.2, 2.2.2, 2.2.3, 2.2.4
2	Robot language classification, Robot language structure, elements and its functions.		
3	Simple programs on Sensing distance and direction.		
4	Simple programs on Sensing distance and direction.		
5	Line Following Algorithms.		
6	Feedback Systems and Other topics on advanced robotic techniques.		

Question Bank: Theory (CO4 - 2.1.2, 2.2.2, 2.2.3, 2.2.4)

1. Explain manual mode of programming in robots.
2. What are the limitations of on-line robot programming?
3. Write down the basic types of robot programming.
4. What are the motion commands available in VAL programming?
5. Explain any two commands associated with the programming of end effectors.
6. Explain the manual lead through programming in robot application. Write about end effectors commands & sensor commands.
7. Write a note on lead –through programming.
8. Explain the various programming methods used in robotics with examples and features of each.
9. What language do robots speak? How do they program robots?
10. What programming language is best for robotics?
11. Can Python be used for robotics?

4.6 f. Unit VI

Developing and Building a Robot (CO4)

Pre-requisites: Mechatronics (TE semester I)

Objective: To teach different programming methods for development and building a robot.

Outcomes:- At the end of the course the Student will be able to **Apply** different programming methods for development and building a robot. (Unit V and VI) (BTL 3- Apply)

Lecture No.	Details of the Topic to be covered	References	CO Addressed
1	Models of flexible links and joints.	T2 and R4	**CO4** 2.1.2, 2.2.2, 2.2.3, 2.2.4
2	Robotic arm – Components and structure.		
3	Types of joints and workspace.		
4	Design models for mechanical arms and lifting systems.		
5	Case Study: 1. Robots in material handling and assembly.		
6	Case Study: 2. Human Robot Interaction.		

Question Bank: Theory - CO4

Theory Paper (CO4 - 2.1.2, 2.2.2, 2.2.3, 2.2.4)

1. What is robotic assembly?
2. What is assembly automation?
3. What is robotics in manufacturing?
4. What are the 5 main components of a robot?
5. How do robots help in manufacturing?
6. What is the most common manufacturing robot made of?
7. What are the different types of drones?
8. What is a drone toy? What can drones do? What's the best drone?
9. What are the best brands of drones? What is the best professional drone?
10. Are autonomous mobile robots safe? How are companies integrating AMRs in general automation? How are companies integrating AMRs in general automation?
11. What is the human robot interface?
12. Is Sophia The robot still alive?
13. What is the use of humanoid robots?
14. How do robots interact with each other?

5. Name of the Subject – Wireless Sensor Networks

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	03	-	-

In-Sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	-	-	100	3

5.1 Syllabus

Unit1: Introduction 6 Hrs
What are Wireless Sensor Networks, Wireless Sensor Node, Anatomy of a Sensor Node, architecture of WSN, Performance metrics in WSNs, types of WSN?

Unit 2: Radio Communication and Link Management 7 Hrs
Radio Waves and Modulation/Demodulation, Properties of Wireless Communications, Medium Access Protocols, Wireless Links Introduction, Properties of Wireless Links, Error Control, Naming and Addressing, Topology Control

Unit 3: Wireless Standards and Protocol Stack 7 Hrs
WSN Standards- IEEE802.15.4 Low rate WPAN, Zigbee, WirelessHART, ISA 100.11a, 6LoWPAN,IEEE802.15.3, Wibree,BLE, Zwave, ANT, Insteon, Wavenis, Protocol stack of WSNs, Cross Layer Protocol Stack

Unit 4: Localization and Routing 7 Hrs
Localization: Localization Challenges and Properties, Deployment Schemes, Proximity Schemes. Ranging Schemes, Range-Based Localization, Range-Free Localization, Routing Basics, Routing Metrics, Routing Protocols, Full-Network Broadcast, Location-Based Routing, Directed Diffusion, Collection Tree Protocol, Zigbee, Multi-Hop Communications

Unit 5: Data Aggregation And Security 7 Hrs
Clustering Techniques, In-Network Processing and Data Aggregation, Compressive Security Issues in Wireless Sensor Networks, Attacks, Defensive Measures, Security requirements and threat model

Unit 6: Designing and Deploying WSN Applications 6 Hrs

Designing and Deploying WSN Applications,Early WSN Deployments, General Problems, General Testing and Validation, Requirements Analysis, The Top-Down Design Process, Bottom-Up Implementation Process.

5.2 Course Objectives

1. To introduce basics concepts of wireless sensor networks. (Unit-I, II)
2. To discuss various standards and protocols associated with wireless sensor networks. (Unit-III)
3. To explain the security, localization, data aggregation and routing techniques used in wireless sensor networks. (Unit-IV, V)
4. To make them aware about issues in design and deployment of wireless sensor network applications. (Unit-VI)

5.3 Course Outcomes

After successfully completing the course students will be able to

CO1.Explain basic concepts used in wireless sensor networks.**(Unit-I,II) (Level-2: Understand)**

CO2. Compare various standards and protocols associated with wireless sensor networks.**(Unit-III) (Level-2: Understand)**

CO3. Describe the security, localization, data aggregation and routing techniques used in wireless sensor networks.**(Unit-IV and V) (Level-2: Understand)**

CO4. Explain the issues involved in design and deployment of WSN application.**(Unit-VI) (Level-2: Understand)**

5.4 Text Books:

T1-1. Kazem Sohraby, Daniel Minoli and TaiebZnati, ― Wireless Sensor Networks Technology, Protocols, and Applications―, John Wiley & Sons, 2007.

T2-2. Holger Karl and Andreas Willig, ―Protocols and Architectures for Wireless Sensor Networks‖, John Wiley & Sons, Ltd, 2005.

5.5 Reference Books:

1. HossamFahmy, ―Wireless Senor Networks: Concepts, Application, experimentation and analysis‖, Springer Publication.

2. Anna Forster, ―Introduction to Wireless Sensor Networks‖, IEEE Press, Wiley Publication.

3. Anna Hac, ―Wireless Sensor Network Designs‖, John Wiley & Sons Ltd.

5.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

https://onlinecourses.nptel.ac.in/noc17_cs07/unit?unit=6&lesson=7
Fundamentals of Wireless Sensor Networks, Willy Publications

5.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	CO Mapped	PI Mapped	Total Lecture Planned	Books Referred
1	I	Introduction	CO1	1.4.1-3	6L	R1, R2
2	II	Radio Communication And Link Management	CO1	1.4.1-3	7L	R2
3	III	Wireless Standards And Protocol Stack	CO2	1.4.1 -3 2.2.2-2 2.2.4-3	6L	R1
4	IV	Localization And Routing	CO3	1.4.1 -3 2.2.2 -2	6L	R2
5	V	Data Aggregation And Security	CO3	1.4.1 -3 2.2.2 -2	7L	R2, R3,T2

6	VI	Designing And Deploying WSN Applications	CO4	1.4.1-3 2.2.2 -2 2.4.3-3	7L	R2

5.8 Unit wise Lecture Plan

5.8 a. Unit No.-I

Pre-requisites:- Computer Networks(Network Definition, OSI Reference model)

Objectives: - The objective of learning the stated unit is:

To introduce basics concepts of wireless sensor networks.

Outcomes: - After successfully completing the course students will be able to
Explain basic concepts used in wireless sensor networks.

Lecture No.	Details of the Topic to be covered	References
1	Introduction	R1,R2
2	What are Wireless Sensor Networks	R1,R2
3	Wireless Sensor Node	R1
4	Anatomy of a Sensor Node	R2
5	Architecture of WSN	R1
6	Performance metrics in WSNs, types of WSN	R1

Question Bank: Theory

Theory Paper

All Question Mapped with CO1-- PI Mapped: 1.4.1-3

Q. 1	What is Wireless Sensor Network? Explain with sample applications.
Q. 2	What are various types Wireless Sensor Networks? Explain any two in detail.
Q. 3	Explain various hardware components of sensor node with the help of diagram.
Q. 4	Write note on Sensor Network Communication Stack
Q. 5	Explain in detail: Architecture of WSN
Q. 6	**Explain** Performance metrics in WSNs

HOT Questions

Q. 1	**What are the** Ad-hoc Networks Characteristics?
Q. 2	Enlist various Research Challenges in Wireless Sensor Networks.

5.8 b. Unit No.-II

Pre-requisites:-Computer Networks and Security (CSMA)

Objectives: -The objective of learning the stated unit is:

To introduce basics concepts of wireless sensor networks.

Outcomes: -After successfully completing the course students will be able to

Explain basic concepts used in wireless sensor networks.

Lecture No.	Details of the Topic to be covered	References
1	Radio Communication And Link Management	R2
2	Properties of Wireless Communications	R2
3	Medium Access Protocols	R2

4	Wireless Links Introduction, Properties of Wireless Links	R2
5	Error Control	R2
6	Naming and Addressing,	R2
7	Topology Control	R2

Question Bank: Theory

Theory Paper

All Question Mapped with CO1--PI Mapped: 1.4.1-3

Q. 1	Write note on Radio waves and Modulation/Demodulation with respect to WSN
Q. 2	What are various properties of WSN?
Q. 3	Explaini. CSMA ii. TDMA iii. Sensor MAC iv. B-MAC
Q. 4	What are different metrics to characterize wireless links and their reliability andquality?
Q. 5	Explain various properties of wireless links?
Q. 6	What is significance naming and addressing in WSN?
Q. 7	What are design criteria of good link estimation protocol?
Q. 8	What is centralized and distributed topology control?

HOT Questions

Q. 1	Write note on Data-Centric Routing Protocols
Q. 2	Write note on Resource-Aware Routing.
Q. 3	Explain Sparse Topology and Energy Management

5.8 c. Unit No.-III

Pre-requisites:-Wireless Networks (Wireless Standards)

Objectives: - The objective of learning the stated unit is:

To discuss various standards and protocols associated with wireless sensor networks.

Outcomes: - After successfully completing the course students will be able to
Compare various standards and protocols associated with wireless sensor networks.

Lecture No.	Details of the Topic to be covered	References
1	WSN Standards- IEEE802.15.4 Low rate WPAN	R1
2	Zigbee, WirelessHART	R1
3	ISA 100.11a , 6LoWPAN,IEEE802.15.3	R1
4	Wibree,BLE,Zwave, ANT	R1
5	Insteon, Wavenis	R1
6	Protocol stack of WSNs , Cross Layer Protocol Stack	R1

Question Bank: Theory

Theory Paper

All Question Mapped with CO2--PI Mapped: 1.4.1 -3 , 2.2.2-2,2.2.4-3

Q. 1	Explain various wireless standards in view of WSN.
Q. 2	Write Note on: IEEE802.15.4 Low rate WPAN, Zigbee,
Q. 3	What is 6LoWPAN Protocol?
Q. 4	Explain IEEE802.15.3 in detail.
Q. 5	Write note on : Wibree,BLE, Zwave

Q. 6	Explain , Protocol stack of WSNs
Q. 7	Compare ANT and BLE protocol.

HOT Questions

Q. 1	Write a note on Microchip MiWi protocol.
Q. 2	What is PAN coordinator
Q. 3	What is RF4CE in Zigbee?
Q. 4	What is Wireless Hart ?

5.8 d. Unit No. -IV

Pre-requisites:- Computer Networks and Security(Routing)

Objectives: -The objectives of learning the stated unit are:

To explain the security, localization, data aggregation and routing techniques used in wireless sensor networks.

Outcomes: -After successfully completing the course students will be able to

Describe the security, localization, data aggregation and routing techniques used in wireless sensor networks.

Lecture No.	Details of the Topic to be covered	References
1	Localization : Localization Challenges and Properties, Deployment Schemes	R2
2	Proximity Schemes. Ranging Schemes , Range-Based Localization, Range-Free Localization	R2
3	Routing Basics, Routing Metrics, Routing Protocols	R2
4	Full-Network Broadcast, Location-Based Routing ,	R2
5	Directed Diffusion, Collection Tree Protocol	R2

6	Zigbee, Multi-Hop Communications	R2

Question Bank: Theory

Theory Paper

All Question Mapped with CO3--PI Mapped: 1.4.1 -3, 2.2.2 -2

Q. 1	Explain in detail: Challenges in Localization
Q. 2	What is Localization? Explain its need.
Q. 3	Describe the SCTP protocol
Q. 4	What are different ranging schemes?
Q. 5	DescribeRange-Based Localization and Range-Free Localization

HOT Questions

Q. 1	What are recent routing protocols used in WSN?
Q. 2	Give Classification of routing protocols used in WSN.
Q. 3	**Explain** LEACH protocol.
Q. 4	Explain Reactive protocols.
Q. 5	Explain Performance analysis of routing protocols.

5.8 e. Unit No.-V

Pre-requisites:- NIL

Objectives: -The objectives of learning the stated unit are:

To explain the security, localization, data aggregation and routing techniques used in wireless sensor networks.

Outcomes: -After successfully completing the course students will be able to

Describe the security, localization, data aggregation and routing techniques used in wireless sensor networks.

Lecture No.	Details of the Topic to be covered	References
1	Clustering Techniques	R2
2	In-Network Processing and Data Aggregation	R2
3	Compressive Sampling	R2
4	Security Issues in Wireless Sensor Networks	T2
5	Security Issues in Wireless Sensor Networks	T2
6	Attacks, Defensive Measures	T2
7	Security requirements and threat model	R3

Question Bank: Theory

Theory Paper

All Question Mapped with CO3--PI Mapped: 1.4.1 -3, 2.2.2 -2

Q. 1	What are different Clustering Techniques?
Q. 2	Write a note on : In-Network Processing and Data Aggregation
Q. 3	What is Data Aggregation in WSN?
Q. 4	Explain Security Issues in Wireless Sensor Networks.
Q. 5	Explain Denial of service attack taking place at each layer.
Q. 6	Explain in detail: Threat model

Q. 7	Describe various security protocols in WSN

HOT questions

Q. 1	What is In network processing.
Q. 2	What is Query Language in TinyDB
Q. 3	What is Agnostic Aggregation in Wireless Sensor Networks
Q. 4	What is evolution based data Aggregation.

5.8 f. Unit No.-VI

Pre-requisites:- NIL

Objectives: - The objectives of learning the stated unit are:

To make them aware about issues in design and deployment of wireless sensor network applications.

Outcomes: - After successfully completing the course students will be able to

Explain the issues involved in design and deployment of WSN application.

Lecture No.	Details of the Topic to be covered	References
1	Designing and Deploying WSN Applications,	R2
2	Early WSN Deployments	R2
3	General Problems	R2
4	General Testing and Validation	R2
5	Requirements Analysis	R2
6	The Top-Down Design Process	R2

7	Bottom-Up Implementation Process.	R2

Question Bank: Theory

Theory Paper

All Question Mapped with CO4--PI Mapped: 1.4.1-3, 2.2.2 -2, 2.4.3-3

Q. 1	Explain in detail: Designing and Deploying WSN Applications
Q. 2	How were Early WSN Deployments?
Q. 3	What are General Problems for Deploying WSN Applications?
Q. 4	What is General Testing and Validation process?
Q. 5	Write a note on : Requirements Analysis,
Q. 6	Explain: Bottom-Up Implementation Process

HOT Questions

Q. 1	Explain in detail Military and Security Applications.
Q. 2	Explain in detail Healthcare and medical applications.
Q. 3	Explain Environmental and ecological applications.