SEMESTER VIII

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ECT 402	WIRELESS COMMUNICATION	2-1-0	3	3
B	ECT 414	BIOMEDICAL ENGINEERING (ELECTIVE III)	2-1-0	3	3
C	ECT 426	REAL TIME OPERATING SYSTEMS (ELECTIVE IV)	2-1-0	3	3
D	ECT 458	INTERNET OF THINGS (ELECTIVE V)	2-1-0	3	3
E	ECT 404	COMPREHENSIVE VIVA VOCE	1-0-0	1	1
U	ECD 416	PROJECT PHASE II	0-0-12	12	4
TOTAL				25/28	17/21

ECT402	WIRELESS COMMUNICATION	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: This course aims to introduce students to basic theory and principles of wireless communication systems in general, and cellular systems in particular. It also introduces basics of radio wave propagation.

Prerequisite: ECT 305 Analog and Digital Communication

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Summarize the basics of cellular system and cellular design fundamentals.
CO2 K2	Describe the wireless channel models and discuss capacity of wireless channels.
CO3 K4	Analyze the performance of the modulation techniques for flat-fading channels and multicarrier modulation.
CO4 K3	Illustrate how receiver performance can be enhanced by various diversity techniques.
CO5 K3	Identify advantages of various equalization techniques and multiple-access techniques in wireless communication.
CO6 K3	Calculate system parameters such antenna height, range, maximum usable frequency in different modes of radio wave propagation.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2		1			2				2
CO2	3	3	3		3							2
CO3	3	3	3		3							
CO4	3	3	3		3							
CO5	3	3	3		3							
CO6	3	3	3									2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember				
Understand	K2	15	15	30
Apply	K3	20	20	40
Analyse	K4	15	15	30
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Summarize the basics of cellular system and cellular design fundamentals. (K2).

1. List certain challenges in the design of a cellular wireless communication system.
2. A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide full-duplex voice & control channels. Compute the number of channels available per cell if the system uses 7-cell reuse.
3. Describe methods to improve coverage and capacity of a cellular system.

Course Outcome 2 (CO2): Describe the wireless channel models and discuss capacity of wireless channels. (K2)

1. Compare and contrast flat-fading and frequency-selective fading channels.
2. How are Doppler spread and coherence time related? What is their significance?
3. Consider a Rayleigh fading channel with average received power of 25dBm. Compute the probability that the received power is below 10dBm.
4. Differentiate between ergodic capacity and capacity with outage.

Course Outcome 3 (CO3): Analyze the performance of the modulation techniques for flat-fading channels and multicarrier modulation. (K4)

1. Under Rayleigh flat-fading, derive an expression for the required average SNR to ensure that outage probability does not below P_{out} .
2. How can subcarrier fading be mitigated?
3. Why is cyclic prefix required in OFDM?

Course Outcome 4 (CO4): Illustrate how receiver performance can be enhanced by various diversity techniques. (K3)

1. Explain receiver diversity technique of maximal ratio combining technique.
2. Describe Almouti scheme for 2x2 MIMO.
3. Find the outage probability of BPSK modulation at $P_b = 10^{-3}$ for a Rayleigh fading channel with SC diversity for M = 1 (no diversity) M = 2. Assume equal branch SNRs of 15 dB.

Course Outcome 5 (CO5): Identify advantages of various equalization techniques and multiple-access techniques in wireless communication. (K3)

1. Describe the steps for LMS algorithm.
2. Compare multiple-access schemes TDMA, FDMA and CDMA.
3. Consider a channel with impulse response h(t) = exp(-t/T) u(t). Find two-tap Zero-forcing equalizer for this channel?

Course Outcome 6 (CO6): Calculate system parameters such antenna height, range, maximum usable frequency in different modes of radio wave propagation. (K3)

1. Derive expression for critical frequency, maximum usable frequency and skip distance (assuming flat earth's surface) for sky wave propagation.
2. A communication system is to be established at a frequency of 50MHz with a transmitter power 1.2kW. The field strength of the directive antenna is 3 times that of a half wave antenna, ht = 50m , hr = 5m. A field strength of 80μV/m is required to give satisfactory reception. Find the range of the system.

SYLLABUS

Module 1: Introduction to Wireless Communication Systems (8 Hours)

1.1 Introduction to Wireless Communication Systems (4): Generations: 2G, 3G, 4G, 5G. Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access -- WiMAX Technology. Wireless Spectrum allocation, Standards.

1.2 Cellular System Design Fundamentals (4): Frequency Reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, trunking and grade off service, improving coverage and capacity – cell splitting, sectoring, microcells.

Module 2: Wireless Channels (7 Hours)

2.1 Path loss and shadowing (1): Free space path loss, Two-Ray model, Shadowing,

2.2 Statistical Multipath Channel Models (4): Time-varying channel impulse response, Narrowband fading, Wideband fading models, Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model.

2.3 Capacity of Wireless Channels (2): Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R. (Derivations of capacity formulae are not required; Only expressions, computations and significance required.)

Module 3: Modulation techniques (7 Hours)

2.1 **Digital Signaling for Flat fading Channels (4):** Analysis of Average Error Probability and Outage probability of BPSK in flat-fading channels.

2.2 **Multi-carrier Modulation (3**): Data transmission using multicarrier modulation for frequency-selective fading channels. Overlapping subchannels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier – OFDM. Cyclic prefix, Peak-to-average-power-ratio.

Module 4: Diversity, Equalization, and Multiple Access (8 Hours)

4.1 Diversity (3 hours): Receiver diversity – selection combining, maximal ratio combining. Transmitter diversity – Alamouti scheme for 2x2 MIMO.

4.2 Equalization (3): Equalization – Linear and non-linear equalization, Zero forcing, MMSE equalizers. LMS algorithm. Adaptive Equalization.

4.3 Multiuser Systems (2): Uplink and Downlink, Multiple Access, Frequency-Division Multiple Access (FDMA), Time-Division Multiple Access (TDMA), Code-Division Multiple Access (CDMA), Orthogonal Frequency-Division Multiple Access (OFDMA).

Module 5 Radio Wave Propagation (7 Hours)

Ground wave propagation, Plane earth reflection, Space wave and surface wave, Spherical earth propagation, Tropospheric waves, Ionospheric propagation, Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.

Text Books

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
2. Theodore S. Rappaport, Wireless communication: Principles and Practice, 2/e, Pearson Education, 1990
3. Aditya Jagannatham, Principles of Modern Wireless Communication Systems, Mc Graw Hill, 2017.
4. Robert Collin, Antennas and Radiowave Propagation, McGraw Hill, 2016.

Reference Books

1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
2. Jochen Schiller, Mobile Communications, Pearson, 2008
3. Andreas F Molish , Wireless Communications, 2nd Edition , Wiley India Publications, 2013
4. W. C. Y. Lee, Mobile Cellular Telecommunication, McGraw Hill,
5. Gordon L. Stuber, Principles of Mobile Communication , Springer,2017
6. Rahim Thafazoli, Technologies for The Wireless Future , Volume 2 , Wiley and Sons , 2004
7. Edward C Jordan and Keith G Balmain, Electromagnetic Wave and Radiating System, Pearson.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to wireless communication systems (8 Hours)**	
1.1	Generations: 2G, 3G, 4G, 5G.	2
1.2	Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access -- WiMAX Technology.	1
1.3	Wireless Spectrum allocation, Standards	1
1.4	Cellular concept, Frequency Reuse, channel assignment strategies,	2

	Handoff strategies	
1.5	Interference and system capacity, trunking and grade off service.	1
1.6	improving coverage and capacity – cell splitting, sectoring, microcells.	1
2	**Wireless Channels (7 Hours)**	
2.1	Free space path loss, Two-Ray model, Shadowing	1
2.3	Time-varying channel impulse response, Narrowband fading	2
2.4	Wideband fading models – Delay spread and Coherence bandwidth, Doppler spread and Coherence time	1
2.5	Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model.	1
2.6	Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R.	2
3	**Modulation Techniques (7 Hours)**	
3.1	Average Probability of error and outage probability	1
3.2	Performance evaluation of BPSK in flat fading channels	2
3.4	Multi carrier modulation in frequency-selective channel	1
3.5	OFDM – DFT/IDFT, Cyclic Prefix	2
3.6	PAPR	1
4	**Diversity, Equalization and Multiple Access (8 Hours)**	
4.1	Receiver Diversity – Selection combining, Maximal ratio combining	2
4.2	Transmit Divesity – Alamouti for 2x2 MIMO	1
4.3	Equalization – linear and nonlinear, ZF and MMSE, LMS, Adaptive	3
4.4	Multiple access – FDMA, TDMA, CDMA, OFDMA	2
5	**Radio Wave Propagation (7 Hours)**	
5.1	Ground wave propagation, Plane earth reflection, Space wave and surface wave	2
5.2	Spherical earth propagation, Tropospheric waves, Ionospheric propagation	2
5.3	Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.	3
	Total Hours	**37**

Simulation Assignments:

1. Simulate flat fading and frequency-selective fading wireless channel models using Python/MATLAB
2. Evaluate BPSK, QPSK, QAM in wirelss fading channels using Python/MATLab.
3. Evaluate zero-forcing and MMSE equalization techniques using Python/MATLAB.
4. Simulation of standard path loss models using Python/MATLab.
5. Simulation of Alamouti scheme using Python/MATLab
6. Students can undertake course projects based on following topics: (a) Channel Modelling of wireless channels (b) Comparison of modulation schemes for wireless system (c) Multi carrier modulation schemes (d) Comparison of equalization techniques (e) Implementation of MIMO schemes.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH. DEGREE EXAMINATION

Course Code: ECT402

Course Name: WIRELESS COMMNICATION

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer ALL Questions. Each Question Carries 3 Marks.)

1. Give important features of 5G system.
2. Discuss different handoff strategies.
3. Explain the notion of delay spread and coherence bandwidth.
4. Give the expression for capacity of flat fading AWGN channel with CSIR. Describe how it is obtained assuming AWGN capacity.
5. Define outage probability.
6. What is the purpose of using cyclic prefix in an OFDM system?
7. Consider a channel with impluse response h(t) = exp(-t/T) u(t). Find tap coefficients of a two-tap zero-forcing equalizer for this channel.
8. Why do we say that maximal ratio combining achieves full diversity?
9. Distinguish between critical frequency and maximum usable frequency.
10. Define virtual height in antennas. [10 X 3= 30]

PART – B

(Answer one question from each module; each question carries 14 marks)

Module I

11. (a) How are co-channel signal-to-interference ratio, cluster size and system capacity are related to one another in a cellular system ? Explain with necessary equations. [07 Marks]

(b) Explain the architecture of wireless LAN (WLAN). [07 Marks]

OR

12. (a) List three differences between 2G and 3G systems. [03 Marks]

(b) A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide full-duplex voice & control channels. Compute the number of channels available per cell if the system uses 7-cell reuse. [03 Marks]

(c) What is cell splitting? How does it improve system performance? [08 Marks]

Module II

13. (a) Explain the effect of multipath propagation using 2-ray model. [07 Marks]

(b) Assuming narrow band fading model, derive statistical characterization of in-phase and quadrature components of a received signal when an unmodulated carrier is transmitted. [07 Marks]

OR

14. (a) Derive time-varying impulse response of multipath wireless channel. [07 Marks]

(b) Consider a flat-fading channel with iid channel gains g[i] which can take on values g1=0.05 with probablity p1=0.1, g2=0.5 with probability p2=0.5, and g3=1 with probability p3=0.4. The transmit power is 10mW, noise spectral density N0 = 10^{-9} W/Hz, and channel bandwidth is 30kHz. Assume instantaneous CSI-R, but transmitter does not have CSI. Compute the capacity of the channel. [07 Marks]

Module III

15. (a) Derive expression for average probability of error in BPSK under Rayleigh flat-fading when symbol duration is roughly equal to channel coherence time. [07 Marks]

(b) What is Peak-to-Average Power-Ratio (PAPR) in OFDM system? How can it be reduced ? [07 Marks]

OR

16. (a) Determine the average SNR per bit of BPSK modulation in Rayleigh slow-fading channel such that 95% of the times, average probability of bit error is less than 10^{-4} . [05 Marks]

(b) Explain multi-carrier modulation in OFDM. [09 Marks]

Module IV

17. (a) Explain Least-Mean-Square algorithm for equalization. [09 Marks]

(b) Compute the average probability of bit error of BPSK under maximal-ratio-combining two-branch diversity with iid Rayleigh fading. Average SNR on each branch is 10dB. [05 Marks]

OR

18. (a) Describe Alamouti scheme for 2x2 MIMO. [07 Marks]

(b) Describe how multiple-access works on uplink and downlink in CDMA.[07 Marks]

Module V

19. (a) Derive an expression for the LOS distance in km when the antenna heights above ground are ht and hr respectively for the transmitter and receiver antennas. [07 Marks]

(b) A receiving antenna is located at 80km from the transmitting antenna. The height of the transmitting antenna is 100m. What is the required height of the receiving antenna? [07 Marks]

OR

20. (a) An HF radio communication is to be established between two points on the earth's surface. The points are at a distance of 2600km. The height of the ionosphere layer is 200km and critical frequency is 4MHz. Find maximum usable frequency. [07 Marks]

(b) Derive expression for critical frequency, maximum usable frequency and skip distance (assuming flat earth's surface) for sky wave propagation. [07 Marks]

ECT414	BIOMEDICAL ENGINEERING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course will introduce aspects of biomedical engineering as applied to biologicalsystems described using engineering principles and the use of modern diagnostic and therapeutic equipment.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand basic bioelectric potentials and its implications in diagnostics
CO2	Understand the principles used for diagnosis of abnormalities in the cardiovascular system
CO3	Explain the techniques used for diagnosis and therapy in the neuromuscular system
CO4	Understand the principle and working of different types of bio medical equipment/device
CO5	Classify various diagnostic medical imaging techniques.

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End semester examination
	I	II	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyze			
Evaluate			
Create			

Mark distribution

Total marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain10 questions with 2 questions from each module, having 3 marks for each question. Studentsshould answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand basic bioelectric potentials and their implications in diagnostics

1. Explain the different types of bio electric potential with diagrams?
2. How does depolarisation and repolarisation occur in a cell?
3. Explain different types of bio-potential electrodes?

Course Outcome 2 (CO2): Explain the principles used for diagnosis of abnormalities in the cardiovascular system

1. Explain ECG machine with a block diagram
2. A patient was subjected to non-invasive method of blood pressure measurement. Which is the method used? What is the principle behind the method and how is it done?

Course Outcome 3 (CO3): Explain the techniques used for diagnosis and therapy in the neuromuscular system

1. Explain with adiagramthe 10-20 system of electrode placement to perform EEG analysis.
2. Explain instrumentation system for acquiring EMG?
3. Explain how functional activity can be elicited from the paralyzed limb of a spinal cord injured patient using electrical stimulation.

Course Outcome 4 (CO4): Understand the principle and working of different types of bio medical equipment/device

1. Explain ventilator parameters?
2. What is a cardiac defibrillator? With a neat diagram explain DC defibrillator.
3. With a neat block diagram explain single channel ECG telemetry transmitter

Course Outcome 5 (CO5): Understand various diagnostic medical imaging techniques

1. Explain the principle of basic pulse echo system with necessary diagrams.
2. Compare NMR imaging and CT imaging.

Syllabus

Module 1

Introduction to bio-medical engineering, overview of anatomy and physiological systems of the body.Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG concept only.)
Electrode theory: Nernst relation, Electrode skin interface, Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes
Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers

Module 2

Heart and cardiovascular system (brief discussion), electro conduction system of the heart. Electrocardiography, ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.
Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method, oscillometric and ultrasonic noninvasive pressure measurements.
Measurement of blood flow: Electromagnetic blood flowmeters and ultrasonic blood flow meters

Module 3

The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.
Electrical activity of muscles- EMG. Signal Acquisition and analysis. Applications of EMG - myoelectric control system.Electrical stimulation of the muscle and nerve, Functional Electrical Stimulation- Principle and applications.
Physiology of respiratory system (overview), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.

Module 4

Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer

Therapeutic Equipments: Principle, block schematic diagram, working and applications of : pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators

Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG and temperature measurement.

Module 5

Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.

Computed Tomograpy: Principle, image reconstruction, scanning system and applications

Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.

Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging

Patient Safety: Electric shock hazards, leakage current,safety codes for electro medical equipments

Text Books

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI, 2nd Edition, 2004

References:

1. John G Webster, “Medical Instrumentation application and design”, John Wiley 3rd e/d
2. J. J. Carr, “Introduction to Biomedical Equipment Technology”, Pearson Education 4th e/d.
3. Richard Aston, “Principle of Biomedical Instrumentation and Measurement”. Merrill Education/Prentice Hall.
4. Barbara Christe, Introduction to Biomedical Instrumentation, Cambridge University Press, 2008

Course Contents and Lecture Schedule

MODULE NO	TOPIC	NO. OF LECTURES
I	Introduction to bio-medical instrumentation system, overview of anatomy and physiological systems of the body.	2
	Sources of bio-electric potential: Resting and action potential, propagation of action potentials, Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG concept only.)	2
	Electrode theory: Nernst relation, Electrode skin interface,	1
	Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes	1
	Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	2
II	Heart and cardiovascular system (brief discussion), electro conduction system of the heart.Electrocardiography	1
	ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.	2
	Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method oscillometric and ultrasonic noninvasive pressure measurements.	2
	Measurement of blood flow: Electromagnetic blood flow meters and ultrasonic blood flow meters	1
III	The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.	2
	Electrical activity of muscles- EMG. Signal Acquisition and analysis. Applications of EMG - myoelectric control system.	2
	Electrical stimulation of the muscle and nerve, Functional Electrical Stimulation- Principle and applications.	1
	Physiology of respiratory system (overview), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	2
IV	Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer	2
	Therapeutic Equipments: Principle, block schematic diagram, working and applications of : pacemakers, cardiac defibrillators	2
	heart–lung machine, dialyzers, surgical diathermy equipment, ventilators	2

	Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine	1
V	Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.	2
	Computed Tomograpy: Principle, image reconstruction, scanning system and applications	1
	Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.	2
	Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	1
	Patient Safety: Electric shock hazards, leakage current,safety codes for electro medical equipments	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
(Electronics & Communication Engineering)
BIOMEDICAL ENGINEERING

Max Marks : 100 **Duration : 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1	What is a microelectrode? List any two	3
2	List three typical features of a biopotential amplifier	3
3	Draw and explain the Einthoven triangle	3
4	List the various blood pressure measurement techniques	3
5	Explain action potential and Resting Potential of brain?	3
6	What is meant by nerve conduction velocity. What is its significance?	3
7	List three ventilator parameters and explain any one.	3
8	What is ventricular defibrillation.	3
9	What are the electric shock hazards?	3
10	Compare NMR imaging and CT imaging.	3

PART B

(Answer one full question from each module)

MODULE 1

11a)	Explain about electrode-electrolyte interface and the electrical activity associated with one contraction in a muscle.	8
b)	Explain isolation amplifier with a neat diagram?	6

OR

12a)	How does depolarisation and repolarisation occur in a cell?	7

b)	Explain chopper amplifier with a neat diagram? State applications	7

MODULE 2

13a)	With necessary illustration, explain any two basic ECG lead configurations.	7
b)	Explain ultrasonic blood flow meter with neat diagram? What are the advantages over other flow meters?	7

OR

14a)	Explain electro conduction system of the heart with illustration	7
b)	Compare direct and indirect blood pressure measurement. What is Korotkoff sound in blood pressure measurement?	7

MODULE 3

15a)	With necessary block schematic explain the principle of operation of a myoelectric controlled prosthetic device.	7
b)	With necessary illustration, explain the placement of electrodes for recording EEG signal.	7

OR

16a)	Explain different respiratory parameters. Explain the working of a spirometer.	7
b)	List six applications of Functional electrical stimulation and explain one application in detail.	7

MODULE 4

17a)	What is a pacemaker? What is its significance? Explain the working with illustration of an atrio-synchronous pacemaker.	7
b)	What is diathermy? With a neat block schematic diagram, explain the working and applications of surgical diathermy equipments.	7

OR

18a)	What is dialysis? Explain any one type of dialyzer with necessary illustration	7
b)	With the help of neat block diagram, explain the components of biotelemetry system	7

MODULE 5

19a)	With a neat block diagram, explain the technique of producing CT images.	7
b)	Explain the principle and any one application of M-mode display in ultrasound systems.	7

OR

20a)	Explain the components of an NMR imaging system with neat block diagram	8
b)	Explain how electric shock is hazardous to human body. What changes it will bring in the body, when the current increases.	6

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ECT426	REAL TIME OPERATING SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: ECT 206 computer Architecture and Microcontrollers

Course objectives: The objectives of this course are to:

1. Identify the basics of general operating systems.
2. Understand the structure and the scheduling operations performed by the operating systems.
3. Introduce Real Time Operating Systems, its basic structure, building blocks and various operations.
4. Summarize the different scheduling algorithms used in RTOS.
5. Identify the different applications of real time operating systems

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Summarize the functions and structure of general-purpose operating systems.
CO2 K3	Use different scheduling algorithms on processes and threads.
CO3 K2	Interpret a real time operating system along with its synchronization, communication and interrupt handling tools.
CO4 K4	Illustrate task constraints and analyze the different scheduling algorithms on tasks.
CO5 K3	Illustrate the applications of real time operating systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		3										
CO 2	2	3										2
CO 3	2	3					2					2
CO 4	2	2					2					2
CO 5	2	3	2				3				2	2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	25	25	50
Apply	K3	10	10	20
Analyze	K4	5	5	10
Evaluate				
Create				

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 numbers): 25 marks

Assignment/Quiz/Case study: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Course Outcome 1 (CO1):

1. List the functions of operating systems.
2. Describe the importance of Kernel in operating system functions.
3. Explain monolithic and layered architecture of operating systems.
4. Draw the process state diagram and explain.

Course Outcome 2 (CO2):

1. Schedule the following processes with FCFS and Round Robin algorithm for a time of2mS. Assuming all the processes arrives at time zero.Also state the performance of the system.

Process	Burst time
P1	4
P2	5
P3	2
P4	3

2. Compare user level threads and Kernel level threads.
3. Discuss the different types of multiprocessor scheduling operations.
4. Explain the possible scheduling of user level threads with a 50mS process quantum and threads that run 5mS per CPU time.

Course Outcome 3 (CO3):

1. Explain the different types of semaphores used for process synchronization.
2. Explain how the priority inversion problem in RTOS is solved.
3. Draw the structure and explain the working of a message queue.
4. Differentiate between exceptions and interrupts.
5. What are the different classifications of exceptions?

Course Outcome 4 (CO4):

1. Explain the different timing constraints of a real time task.
2. Illustrate Jackson's algorithm with an example.
3. Explain EDF algorithm with precedence constraints.
4. Verify the schedulability under EDF and construct the schedule of the following task set

	Ci	Di	T1
r_1	2	5	6
r_2	2	4	8
r_3	4	8	12

5. Draw the state transition diagram of a real time kernel.

Course Outcome 5 (CO5):

1. Illustrate the implementation of a real time system with an example,
2. With a block schematic explain the real time control system used in an adaptive cruise control.

Syllabus

Module	Course contents	Hours
I	Operating system: Types, Objectives and functions , Kernel, Process - States, Process Control Block, Operations on processes.	6
II	Process Scheduling: FCFS, SJF, Priority, Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling. Thread: Structure.User and kernel level threads, multi-threading models, multiprocessor scheduling.	7
III	Real Time Operating Systems: Structure and characteristics of Real Time Systems, Task: Task states, Task synchronization -Semaphores- types, Inter task communication mechanisms: message queues, pipes, event registers, signals, Exceptions and interrupt handling.	8
IV	Task constraints, Task scheduling: Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints. Periodic task scheduling:Rate monotonic and Deadline monotonic, Real time Kernel- Structure, State transition diagram, Kernel primitives.	8
V	Features of FreeRTOS and Linux Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only. Case study of (Kernel design, threads and task scheduling) RTOS: MicroC/OS-II. RTOS control system used in real life applications - in adaptive cruise control.	6

Text Books

1.Abraham Silberschatz- 'Operating System Principles': Wiley India,7th edition, 2011
2.William Stallings –'Operating systems- Internals and design principles', Prentice Hall, 7th edition, 2011
3.Qing Li – 'Real-Time Concepts for Embedded Systems ', CMP Books, 2013
4.Giorgio C. Buttazzo, -'HARD REAL-TIME COMPUTING SYSTEMS Predictable Scheduling Algorithms and Applications', Kluwer Academic Publishers.

Reference Books:

1. Tanenbaum -'Modern Operating Systems' ,Pearson Edition, 3/e, 2007.
2. Jean J Labrosse , 'Micro C/OS-II, The Real Time Kernel' , CMP Books, 2011
3. Rajib Mall, 'Real-Time Systems: Theory and Practice ' , 2008.
4. David E. Simon 'An Embedded Software Primer', Pearson 2012
5. Raj Kamal, 'Embedded Systems – Architecture, Programming and Design',Tata McGraw Hill

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Introduction to Operating system- Types, Objective and functions	2
1.2	Kernel - Importance and functions	2
1.3	Process - States, Process Control Block, Operations on processes	2
	MODULE II	
2.1	Process Scheduling: FCFS, SJF, Priority, Round-Robin	2
2.2	Multilevel Queue and Multilevel Feedback Queue Scheduling	2
2.3	Thread- Structure. User and kernel level threads, Multi-threading models	2
2.4	Multiprocessor scheduling	1
	MODULE III	
3.1	Real Time Operating Systems: Structure and characteristics of Real Time Systems	1
3.2	Task: Task states	1
3.3	Task synchronization -Semaphores- types	2
3.4	Inter task communication mechanisms: message queues, pipes, event registers, signals	2
3.5	Exceptions and interrupt handling	2
	MODULE IV	
4.1	Task constraints	1
4.2	Task scheduling: Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints	3
4.3	Periodic task scheduling: Rate monotonic, Deadline monotonic	2
4.4	Real time Kernel- Structure, State transition diagram, Kernel primitives	2
	MODULE V	
5.1	Features of FreeRTOS and Linux	1
5.2	Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only.	2
5.3	Case study of RTOS: MicroC/OS-II real time operating systems.	2
5.4	RTOS control system used in real life applications - in adaptive cruise control.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VIII SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT426

Course Name: REAL TIME OPERATING SYSTEMS

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries 3 marks**	
1.	List any six functions of an operating system.	3
2	Differentiate microkernel and exokernel structures of operating systems.	3
3	Explain the different operations on processes.	3
4	Explain the differences between Pre-emptive and Non pre-emptive scheduling policies.	3
5	Draw the state diagram of RTOS queue and explain.	3
6	What you mean by priority inversion in real time systems? How the operating system manages this issue?	3
7	Explain EDD algorithm with an example.	3
8	Explain the task control block of a real time kernel.	3
9	List the features of FreeRTOS.	3
10	Illustrate the threads in MicroC/OS-II operating system.	3
	PART B **Answer any one full question from each module, Each question carries 14 marks.**	
	MODULE 1	
11	a. Explain the functions of operating system as Resource Manager.	7
	b. Describe the structure of a Process Control Block	7
	OR	
12	a. Explain the monolithic and microkernel architectures of OS kernel.	7
	b. Draw the process state diagram and explain the different states.	7
	MODULE II	

<table>
<tr><td>13</td><td>a. Explain the Shortest Remaining Time First algorithm with a suitable example.</td><td>7</td></tr>
<tr><td></td><td>b.Schedule the given 5 processes with Round Robin scheduling.

<table><tr><th>Process ID</th><th>Arrival Time</th><th>Burst Time</th></tr><tr><td>P1</td><td>0</td><td>5</td></tr><tr><td>P2</td><td>1</td><td>3</td></tr><tr><td>P3</td><td>2</td><td>1</td></tr><tr><td>P4</td><td>3</td><td>2</td></tr><tr><td>P5</td><td>4</td><td>3</td></tr></table>Draw the Gantt chart and calculate the average waiting time and turn-around time for these processes if time quantum is 2 units,</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>14</td><td>Compare FCFS and Round -Robin scheduling algorithms</td><td>7</td></tr>
<tr><td></td><td>b. Explain thread scheduling algorithms used in operating systems in detail.</td><td>7</td></tr>
<tr><td></td><td>MODULE III</td><td></td></tr>
<tr><td>15</td><td>a .Draw the structure of a real time operating system and explain.</td><td>7</td></tr>
<tr><td></td><td>b. Differentiate between exceptions and interrupts. What are the different classifications of exceptions</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>16</td><td>a. Explain how synchronization is achieved between different tasks in a real time operating system</td><td>7</td></tr>
<tr><td></td><td>b.Describe any two inter task communication mechanisms in a real time operating systems.</td><td>7</td></tr>
<tr><td></td><td>MODULE IV</td><td></td></tr>
<tr><td>17</td><td>a. Illustrate Horn’s algorithm with an example.</td><td>7</td></tr>
<tr><td></td><td>b. Explain EDF algorithm with precedence constraints.</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>18</td><td>a. Explain the precedence constraints of a real time task.</td><td>7</td></tr>
</table>

<table>
<tr><td></td><td>b. Verify the schedulability and construct the scheduling according to the rate monotonic algorithmfor the following set of periodic tasksΓ_1, Γ_2 and Γ_3.
<table><tr><td></td><td>Ci</td><td>Ti</td></tr><tr><td>Γ_1</td><td>3</td><td>5</td></tr><tr><td>Γ_2</td><td>1</td><td>8</td></tr><tr><td>Γ_3</td><td>1</td><td>10</td></tr></table>Where Ci and Ti are the computation time activation period of the task.</td><td>7</td></tr>
<tr><td></td><td>MODULE V</td><td></td></tr>
<tr><td>19</td><td>a.Illustrate the implementation of a real time system with an example,</td><td>7</td></tr>
<tr><td></td><td>b. Explain the inter-process communication techniques used in Micro C/OS-II</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>20</td><td>a. Compare the features of PSOS, VRTX and RT Linux</td><td>7</td></tr>
<tr><td></td><td>b. Prepare suitable requirements table for an RTOS control system used in adaptive cruise control.</td><td>7</td></tr>
</table>

ECT458	INTERNET OF THINGS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course aims to develop skills in IoT system development and to apply the same in real life applications.

Prerequisite: ECT342 Embedded systems

Course Outcomes: After the completion of the course,a student will be able to

CO 1 K1	Understand the IoT fundamentals and architecture modelling (K1)
CO 2 K2	Understand the smart things in IoT and functional blocks (K2)
CO3 K2	To understand the communication networks and protocols used in IoT. (K2)
CO 4 K3	To understand the cloud resources, data analysis and applications. (K3)
CO5 K3	To apply the IoT processes in embedded applications. (K3)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	20	10	20
Understand	K2	30	20	40
Apply	K3	0	20	40
Analyse				

Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the IoT fundamentals and architecture modelling (K1)

1. What is the definition of IoT and different characteristics of IoT

2. Define the architectural view of IoT and functional blocks

3. What are the different levels of IoT

Course Outcome 2 (CO2): Understand the smart things in IoT and functional blocks (K2)

1. What are the different smart things in IoT

2. How the communication is established among nodes and nodes and cloud.

3. What are the protocols that are used in IoT

Course Outcome 3 (CO3): To understand the communication networks and protocols used in IoT. (K2)

1. Differentiate between IEEE standard protocols

2. Explain the advantages of next generation IP based protocols used in ioT

3. Define different layers used in embedded protocols

Course Outcome 4 (CO4): To understand the cloud resources, data analysis and applications. (K3)

1. Explain how data is stored in IoT environment and processed

2. How to use cloud resources and different options available

3. How end devices can be used to control input and output devices

Course Outcome 5 (CO5): To apply the IoT processes in embedded applications. (K3)

1. What are the security and privacy concerns of IoT

2. Explain the typical applications of IoT.

3. Describe the processes involved in implementing a smart city.

SYLLABUS

Module 1 (7 Hours)
Introduction to IoT technology: Definitions and Characteristics of IoT, IoT Architectural View, Physical Design of IOT, Logical Design of IoT- IoT Functional blocks, IoT communication models, IoT Enabling Technologies, IoT Levels & Deployment Templates.

Module 2 (7 Hours)
IoT and M2M- M2M, Difference between IoT and M2M, SDN and NFV for IoT, Smart Objects: The "Things" in IoT: Sensors, Actuators, and Smart Objects, Sensor Networks- Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks- Connecting Smart Objects- Communication Criteria.

Module 3 (7 Hours)

Unified Data Standards –Protocols –IEEE 802.15.4 -The Physical Layer, The Media-Access Control Layer, Uses of 802.15.4 ,The Future of 802.15.4: 802.15.4e and 802.15.4g–Modbus–ZigBee-Zigbee Architecture- LoRaWAN -Standardization and Alliances, Physical Layer, MAC Layer, Topology, LTE-M, NB-IoT-Network layer –The next generation: IP-based protocols - 6LoWPAN and RPL, Overview of the 6LoWPAN Adaptation Layer .

Module 4 (9 hours)
Data Collection, storage and computing Using a Cloud Platform-Introduction, Cloud Computing Paradigm for Data Collection, Storage and Computing-Cloud Computing Paradigm, Cloud Deployment Models-Everything as a Service and Cloud Service Models-SaaS, PaaS, IaaS, DaaS. Cloud based platforms-XIVELY, NIMBITS.

IoT Physical Devices & Endpoints-IoT Device-Building blocks –Raspberry-Pi -Board-Linux on Raspberry-Pi-Raspberry-Pi Interfaces (serial, SPI, I2C). Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices). Controlling GPIO outputs and displaying sensor readings using web interface/cloud (Python programming is required only for assignments and projects and not for examinations. Other end nodes and platforms can also be used).

Module 5 (6 Hours)

IoT privacy, security and vulnerabilities solutions, vulnerabilities, security requirements, threat analysis, security tomography, layered attacker model, Identity management, access control, secure message communication.

Smart and Connected Cities-An IoT Strategy for Smarter Cities-Vertical IoT Needs for Smarter Cities, Global vs. Siloed Strategies-Smart City IoT Architecture-Street Layer, City Layer, Data Center Layer, Services Layer- Smart City Security Architecture - Smart City Use-Case Examples – Street lighting, smart parking, smart traffic and air pollution monitoring

Maximum 35 /36 Hours

Text Books

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on- Approach)", 1st Edition, VPT, 2014 (Module1,2,4)
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. (Module2,3,5)
3. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited.
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, SimonMonk, O'Reilly (SPD), 2016, ISBN.

Reference Books/Papers

1. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things –Key applications and Protocols", Wiley, 2012 (Module 3)
2. Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347- 2376.
3. The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by SamuelGreengard
4. The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, OviduVermesan and Peter Friess, RiverPublishers.
5. Internet of Things - From Research and Innovation to Market Deployment-RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
6. Internet of Things Security and Data Protection, Sébastien Ziegler,Springer International Publishing 2019.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Internet of Things- 7Hrs**	
1.1	Introduction, definition and characteristics	1
1.2	IoT architectural view, functional blocks	2
1.3	IoT Communication models, enabling technologies	2
1.4	IoT deployment levels	2
2	**Essential components of IoT- 7Hrs**	
2.1	IoT and M2M	2
2.2	Smart objects	2
2.3	Wireless sensor networks	3
3	**IoT protocols- 7Hrs**	
3.1	IEEE 802.15.4 protocols	2
3.2	Zigbee	1
3.3	6LoWPAN and RPL	2
3.4	LoraWAN, LTE-M and NB-IoT	2
4	**Cloud storage and Programming the end device- 9Hrs**	
4.1	Data storage and computation	3
4.2	Physical devices and end points	2
4.3	Raspberry pi programming	4
5	**Security and Applications-6 Hrs**	
5.1	Security and Privacy	2
5.2	Smart city application	2
5.3	Use case examples	2

Simulation Assignments:

1. At least one assignment should be programming examples (python or any other language) using Raspberry pi (Other options like arduino, node mcu etc. can also be used) Include I/O interfacing, SPI, I2C, serial, sensor interfacing and web interface.
2. Another assignment shall be an IoT system implementation of mini project consisting of a sensor, processing device, communication device and cloud storage (This can be individual or group projects). Mini project is essential for understanding the concepts of IoT.
3. Mini project can be done in the following areas.
    a) Smart city (b) Weather monitoring system (c) air pollution monitoring (d) Smart parking (e) smart traffic (f) any other application/s where sensors/actuators devices are used.

4. Programming and mini project are essential for understanding the concepts of IoT.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

(Model Question Paper)

Course Code: ECT458

Course Name: INTERNET OF THINGS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer for all questions. Each Question Carries 3 marks)

1. List any five characteristics of IoT
2. What are the IoT enabling technologies?
3. What is a wireless sensor network?
4. What are the limitations of smart objects in WSNs??
5. Explain the need for IP optimization in IoTs?
6. What are the transmission modes used in modbus?
7. What are the 4 different cloud deployment models? Explain
8. What is cloud computing? Explain.
9. List the five functional units of security
10. What is message integrity? How it is checked? [10 X 3 = 30 Marks]

PART – B

(Answer one question from each module; each question carries 14 Marks)

Module – I

11. (a) Write a note on physical design of IoT. [06 Marks]
    (b) Give a detailed description of the link layer, network layer, transport layer and application layer protocols. [08 Marks]

OR

12. (a) What are the functional blocks of IoT? Explain? [07 Marks]
    (b) Discuss different communication models used in IoT. [07 Marks]

Module – II

13. (a) What are the differences between IoT and M2M? [07 Marks]
    (b) What are the issues of conventional networking architectures? How is it solved in SDN? [07 Marks]

OR

14. (a) What are smart objects? What are their characteristics and the trends in smart objects? [07 Marks]
(b) What are the characteristics and attributes to be considered for connecting smart objects ? [07 Marks]

Module – III

15. (a) Explain IEEE 802.15.4 physical layer, MAC layer and security implementation with the help of frame formats. [09 Marks]
(b) What are the modifications included in IEEE 802.15.4 e and g versions as compared to IEEE 802.15.4? [05 Marks]

OR

16. (a) With the help of a diagram explain the Zigbee protocol architecture. [07 Marks]
(b) Explain LoraWAN architecture. Give a detailed description of the physical layer and MAC layer of LoraWAN [07 Marks]

Module – IV

17. (a) Write a note on different cloud service models [06 Marks]
(b) What is virtualization in cloud computing? Explain the features, advantages and concerns of cloud computing. [08 Marks]

OR

18. (a) With the help of a diagram explain the basic building blocks of an IoT device [07 Marks]
(b) Explain cloud based data collection, storage and computing services provided by XIVELY cloud platform. [07 Marks]

Module – V

19. (a) What is security and Privacy? List the 10 vulnerabilities of IoT. [07 Marks]
(b) Explain the layered attacker model. [07 Marks]

OR

20. (a) With the help of a diagram explain the 4 layer smart city architecture. [07 Marks]
(b) Write a note on street lighting architecture with the help of a diagram [07 Marks]

ECT404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

ECD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. ·[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						