RSET

RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY

COURSE HAND-OUT

B.TECH. - SEMESTER VII

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING (EC), RSET

VISION

TO EVOLVE INTO A CENTRE OF EXCELLENCE IN ELECTRONICS AND COMMUNICATION ENGINEERING, MOULDING PROFESSIONALS HAVING INQUISITIVE, INNOVATIVE AND CREATIVE MINDS WITH SOUND PRACTICAL SKILLS WHO CAN STRIVE FOR THE BETTERMENT OF MANKIND

MISSION

TO IMPART STATE-OF-THE-ART KNOWLEDGE TO STUDENTS IN ELECTRONICS AND COMMUNICATION ENGINEERING AND TO INCULCATE IN THEM A HIGH DEGREE OF SOCIAL CONSCIOUSNESS AND A SENSE OF HUMAN VALUES, THEREBY ENABLING THEM TO FACE CHALLENGES WITH COURAGE AND CONVICTION

B.TECH PROGRAMME

Program Outcomes (POs)

Engineering students will be able to

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, Engineering fundamentals, and Electronics and Communication Engineering to the solution of complex Engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze 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 the need for sustainable developments.
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.

Program-Specific Outcomes (PSOs)

Engineering students will be able to:

1. Demonstrate their skills in designing, implementing and testing analogue and digital electronic circuits, including microprocessor systems, for signal processing, communication, networking, VLSI and embedded systems applications;

2. Apply their knowledge and skills to conduct experiments and develop applications using electronic design automation (EDA) tools;

3. Demonstrate a sense of professional ethics, recognize the importance of continued learning, and be able to carry out their professional and entrepreneurial responsibilities in electronics engineering field giving due consideration to environment protection and sustainability.

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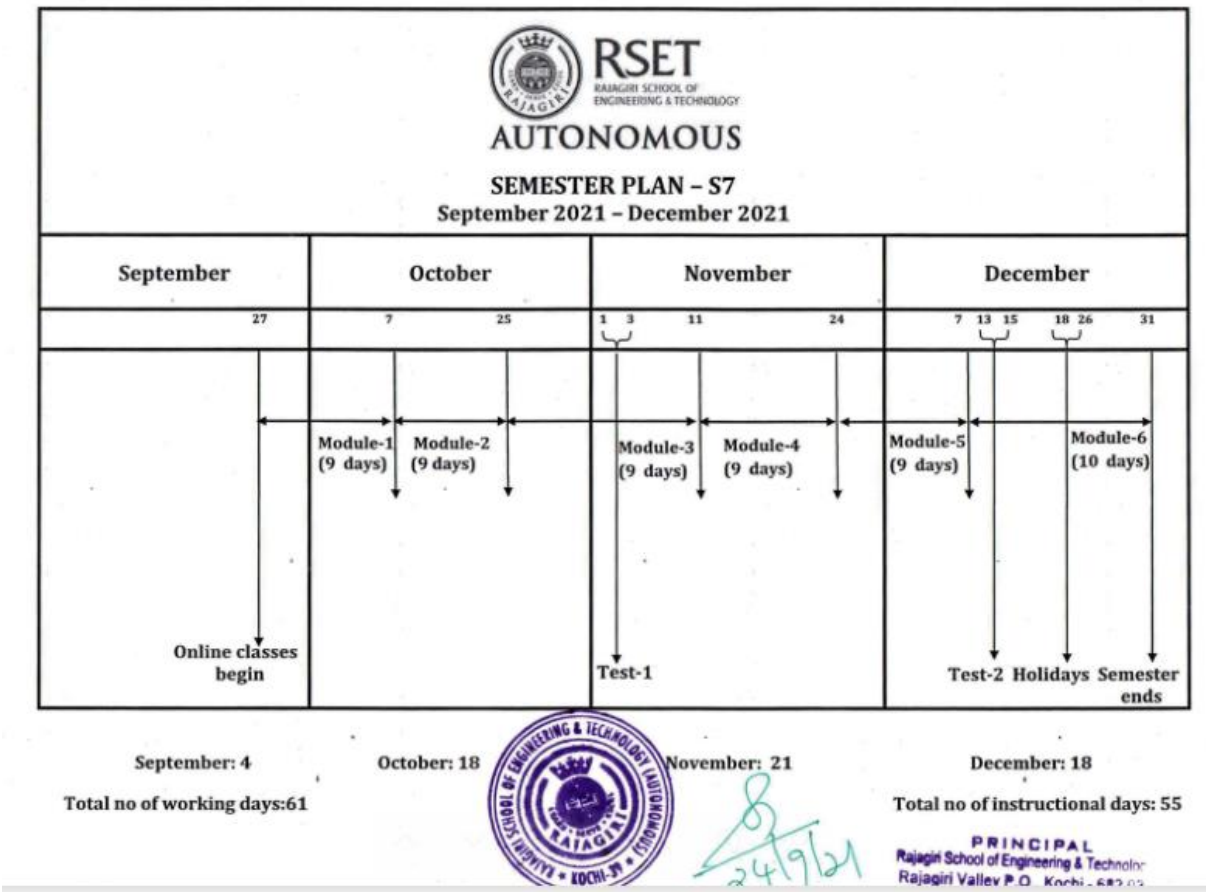
1. SEMESTER PLAN



2. SCHEME

SLOT	Code	Subject	Hours/Week			Credits
			L	T	P	
A	EC 401	Information Theory & Coding	4	0	0	4
B	EC403	Microwave & Radar Engg	3	0	0	3
C	EC 405	Optical Communication	3	0	0	3
D	EC 407	Computer Communication	3	0	0	3
E	EC 409	Control System	3	0	0	3
F		Electives	3	0	0	3
S	EC 451	Seminar & Project Preliminary	0	1	4	2
T	EC 431	Communication Systems Lab (Optical & Microwave)	0	0	3	1

EC 401

INFORMATION THEORY AND CODING

COURSE INFORMATION SHEET

PROGRAMME: U.G.	DEGREE: BTECH
COURSE: **INFROMATION THEORY AND CODING**	SEMESTER: **Seven** CREDITS: 4
COURSE CODE: **EC 401** REGULATION: 2015	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: Digital Communication	CONTACT HOURS: 4 hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY):	LAB COURSE NAME:

SYLLABUS:

UNIT	DETAILS	HOURS
I	Introduction to Information Theory. Concept of information, units, entropy, marginal, conditional and joint entropies, relation among entropies, mutual information, information rate. Source coding: Instantaneous codes, construction of instantaneous codes, Kraft's inequality, coding efficiency and redundancy	9
II	Noiseless coding theorem , construction of basic source codes, Shannon-Fano Algorithm, Huffman coding, Channel capacity – redundancy and efficiency of a channel, binary symmetric channel (BSC), Binary erasure channel (BEC) – capacity of band limited Gaussian channels	9
III	Continuous Sources and Channels: Differential Entropy, Mutual information, Waveform channels, Gaussian channels, Shannon – Hartley theorem, bandwidth, SNR trade off, capacity of a channel of infinite bandwidth, Shannon's limit	9
IV	Introduction to rings, fields, and Galois fields. Codes for error detection and correction – parity check coding – linear block codes – error detecting and correcting capabilities – generator and parity check matrices – Standard array and syndrome decoding	9
V	Perfect codes, Hamming codes, encoding and decoding Cyclic codes, polynomial and matrix descriptions, generation of cyclic codes, decoding of cyclic codes BCH codes, Construction and decoding, Reed Solomon codes	9
VI	Convolutional Codes – encoding – time and frequency domain approaches, State Tree & Trellis diagrams – transfer function and minimum free distance – Maximum likelihood decoding of convolutional codes – The Viterbi Algorithm. Sequential decoding.	9
TOTAL HOURS		54

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	P S Sathya Narayana, Concepts of Information Theory & Coding, Dynaram Publications, 2005
2	Simon Haykin: Digital Communication Systems, Wiley India, 2013.

3	Bose, Information theory coding and cryptography, 3/e McGraw Hill Education India , 2016
4	D.E.R. Denning, Cryptography and Data Security, Addison Wesley, 1983.
5	J S Chitode, Information Theory and Coding, Technical Publications, Pune, 2009
6	Kelbert & Suhov, Information theory and coding by examples, Cambridge University Press, 2013
7	Shu Lin & Daniel J. Costello. Jr., Error Control Coding : Fundamentals and Applications, 2/e, Prentice Hall Inc., Englewood Cliffs, NJ,2004

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
MA 201	ENGINEERING MATHEMATICS – III	Linear Algebra & Complex Analysis	**3**
MA 202	ENGINEERING MATHEMATICS - IV	Probability distributions, Transforms and Numerical Methods	**4**
EC 302	DIGITAL COMMUNICATION	Analyze Digital Communication System	**6**

COURSE OBJECTIVES:

To introduce the concept of information
To understand the limits of error free representation of information signals and the transmission of such signals over a noisy channel
To design and analyse data compression techniques with varying efficiencies as per requirements
To understand the concept of various theorems proposed by Shannon for efficient data compression and reliable transmission
To give idea on different coding techniques for reliable data transmission
To design an optimum decoder for various coding schemes used.

COURSE OUTCOMES:

Sl.No.	DESCRIPTION
1	Students will be able to understand the concept of information and entropy
2	Students will be able to design a lossless transmission system on the basis of channel capacity and source coding theorem
3	Students will be able understand the basics of Gaussian Channel & Shannon's Limit
4	Students will be able to analyze error correction and detection using linear block codes.
5	Students will be able to analyze error correction and detection using cyclic codes.
6	Students will be able to implement encoding and decoding of convolutional codes.

CO-PO-PSO MAPPING:

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	3	1									2	3	2	
2	3	3	2		2							2	3	2	
3	3	3	2		2							2	1	1	
4	3	3	3		2							2	3	2	
5	3	3	3		2							2	3	2	
6	3	3	3		2							2	3	2	
EC 401	**2.8**	**3**	**2.3**		**2**							**2**	**2.6**	**1.8**	

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE ABOVE.

CO1	PO1	Information concept and mathematical formulation of information
	PO2	Probability requirements for information analysis
	PO3	Construction of codes for source coding
	PO12	For 5g and millimeter wave and IOT requirements shannons contribution
	PSO1	Sampling ,shannons theorem ,Probability aspects
	PSO2	FCC broad band allocation
CO2	PO1	Basic concept of source coding & lossless transmission
	PO2	Mathematical formulation of noiseless coding
	PO3	Limiting case of noiseless coding and complex channels
	PO5	Mathematical modeling for channels
	PO12	Channel complexity
	PSO1	Communication and signal processing background for different channels
	PSO2	MatLab code for noiseless coding
CO3	PO1	Differential Entropy
	PO2	SNR Trade off & Channel capacity calculations
	PO3	Application of Shannon Hartley theorem & Shannon's limit
	PO5	Mathematical modeling for channels
	PO12	Complex analysis of noise due to heavy traffic
	PSO1	Communication and signal processing background for Noise analysis

	PSO2	MatLab code for noise modelling
CO4	PO1	Study of rings, groups & fields.
	PO2	Algebra background for coding
	PO3	Application oriented coding techniques
	PO5	MatLab for coding
	PO12	Study of linear block codes for error correction
	PSO1	Signal processing and communication aspects of coding
	PSO2	Setting lab experiments for understanding coding
CO5	PO1	Basic concept of error correction & detection.
	PO2	Algebra background for coding
	PO3	Application oriented coding techniques
	PO5	MatLab code for error correction & detection.
	PO12	Study of cyclic codes for error correction
	PSO1	Signal processing and communication aspects of error correction techniques.
	PSO2	MatLab codes for error correction & detection.

CO6	PO1	Time & frequency domain approaches for convolutional codes.
	PO2	Algebra background for coding
	PO3	Application of maximum likelihood decoding
	PO5	MatLab code for encoding & decoding of convolutional codes
	PO12	Study of convolutional codes – encoding & decoding.
	PSO1	Signal processing and communication aspects of error correction techniques.
	PSO2	MatLab codes for sequential decoding

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	Decoding techniques of various coding	ASSIGNMENT	1,2,3,5,12
2			

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Probability, and Random Process advanced theory	1,2,3,12
2	Digital Communication Techniques advanced topics	1,2,3,12

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Analysis of various coding schemes	1,2,3,12

WEB SOURCE REFERENCES:

1	http:// http://nptel.iitm.ac.in/courses.php?disciplineId=117, http://www.nptel.iitm.ac.in/courses/117101053/
2	http://www.slideshare.net/rogerpitiot/information-theory
3	http://www.edutalks.org/beta/downloads/INFORMATION_%20THEORY.pdf
4	http://www.scribd.com/collections/3855510/Information-theory

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

■ CHALK & TALK	■ STUD. ASSIGNMENT	■ WEB RESOURCES	
. LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT [Append details of assessment methodologies actually employed (including design and analysis assessment) in spreadsheet format after the completion of each semester

■ ASSIGNMENTS	■ STUD. SEMINARS	■ TESTS/MODEL EXAMS	■ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

■ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	■ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by **Approved by**

Anila Kuriakose

Abhishek Viswakumar

Swapna Davis **HOD**

COURSE PLAN

UNIT	DETAILS	HOURS
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SAMPLE QUESTION

MODULE 1

1. A binary channel transmitting at the bit rate of R = 40000 bps is used for transmitting PCM voice signal. What will be the appropriate sampling rate fs, quantizing level L, and the binary digit number if the maximum frequency in the signal is 3.6 kHz?

2. A memoryless source emits n symbols each with probability p. Which among the following would be the entropy of the source as a function of n?
   a. increases as log (n)
   b. decreases as log (1/n)
   c. increases as n
   d. increases as n log (n)

3. During transmission over a certain binary communication channel, bit errors occur independently with probability p. The probability of at most one bit in error in a block of n bits is given by which among the following?
   a. pn
   b. $1 - pn$
   c. $np(1 - p)n-1+ (1 - p)n$
   d. $1 - (1 - p)n$

4. Five possible messages mi, i = 1, 2, …, 5 have probabilities ½, ¼, ⅛, 1/16, and 1/16, respectively. Find the entropy.

5. Six possible messages mi, i = 1, 2, …, 6 have probabilities ⅛, ⅛, 2/8, 2/8, ⅛, and ⅛, respectively. Find the entropy.

6. Four messages mi, i = 1, 2, …, 4 have probabilities ½, ¼, ⅛, and ⅛:
   a. Calculate entropy H.
   b. If r = 1 message per second, find rate of information transfer R.

7. Four messages mi, i = 1, 2, …, 4 have probabilities ½, ¼, ⅛, and ⅛:
   a. Find the rate at which the binary digits will be transmitted if the signal is encoded as 00, 01, 10, and 11.
   b. Find the rate at which the binary digits will be transmitted if the signal is encoded as 0, 01, 10, 110, and 111.

8. Six messages mi, i = 1, 2, …, 6, have probabilities ⅛, ⅛, ¼, ¼, ⅛, and ⅛, respectively. Find the entropy.

9. M messages have probabilities pi, i = 1, 2, …, M. If M = 3, write down an expression for H using the result p1 + p2 + p3 = 1.

10. A code is composed of dots and dashes. One dash = 3 dots. Probability of occurrence of dash is 1/3 the probability of dot. Find the information content of a dot.

11. State and prove the properties of mutual information.

12. Explain the concept of information associated with message. Why the information is is a measure used for measuring the amount of information?

13. A source has two symbol whose probability of occurrences respectively are p(i)=1/8, p(j)=7/8. Determine entropy of the source?
14. Define self information, entropy, information rate and memory less source in the case of information theory?
15. Write the condition for Kraft inequality?
16. (i) Explain the properties of entropy. Write the expression for source efficiency.
    (ii) A memory less source is emitting an independent sequence of 0's and 1's with probabilities 'p' and '(1-p)' respectively. Plot the entropy of the source.
17. (i) Show the entropy is maximum when the source transmits symbols with equal probability. Plot the entropy of this source versus p (0<p<1).
    (ii) The output of a DMS consists of the possible letters $x_1,x_2,\ldots..x_n$ which occur with probabilities $p_1,p_2,\ldots\ldots p_n$ respectively. Prove that the entropy H(x) of the source is log n.

18. Explain mutual information and prove that the mutual information of a channel is symmetric.
19. (i) Give the different properties of entropy of a memoryless source. Prove the extremal Property.
    (ii) Explain the source efficiency with the help of expressions.

20. Three BSC's each with error probability 0.1 are cascaded as shown in the following Fig 1. P(0)=1/4, p(1)=3/4. Calculate H(Y), H(Z), H(V), I(X,Z), I(X,U).

21. A television picture is composed of 600 picture elements in a horizontal line and 500 picture elements in the horizontal lines per frame. Each of these elements can assume 10 distinguishable brightness levels with equal probability. Find the information content of a television picture frame.
22. Determine different entropies H(X), H(Y), H(X,Y), H(X/Y), H(Y/X), I(X,Y) for the JPM given below and verify their relationships.

23. (i) Calculate the entropy rate of a conventional telegraph source with dash twice as long as adot and half as probable. The dot last for 0.2ms and the same interval exist for the pause between the symbols.
    (ii) Suppose a radio announcer has a vocabulary of 10,000 words and that he makes an announcement of 1000 words, selecting these words from his vocabulary in a completely random fashion. What is the amount of information conveyed by him to a listener?

MODULE 2

1. Encode the following messages with their respective probability using basic Huffman algorithm. calculate the efficiency of coding and comment on the result

M1	M2	M3	M4	M5	M6	M7	M8
1/2	1/8	1/8	1/16	1/16	1/16	1/32	1/32

2. State and prove the source coding theorem.

3. Why is source encoding in data communication done?

   a. to enhance the information transmission rate
   b. to reduce transmission errors
   c. to conserve transmitted power
   d. to facilitate clock recovery in the receiver

4. A discrete memory less source has an alphabet of seven symbols whose probabilities of occurrence are as described below

Symbol	S0	S1	S2	S3	S4	S5	S6
Probability	0.25	0.25	0.0625	0.0625	0.125	0.125	0.125

Compute the Huffman code for this source moving combined symbols as high as possible

5. A information source produces sequences of independent symbols having the following probabilities

A	B	C	D	E	F	G
1/3	1/27	1/3	1/9	1/9	1/27	1/27

a. Construct a binary code using Shannon-Fano procedure and find its efficiency and redundancy.

b. Construct a ternary code using the same procedure and find its efficiency and redundancy.

6. A discrete memory less source has an alphabet of seven symbols with probabilities for its output as described here

S0	S1	S2	S3	S4	S5	S6
0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute the Huffman code for this source, moving the composite symbol as high as possible. Explain why the computed source code has an efficiency of 100%.

7. A discrete memory less source with 3 symbols X1,X2 and X3,having probabilities 0.3,0.4 and 0.3 respectively is to be encoded in binary form

a. Huffman coding scheme without extension.

b. Huffman coding scheme with 2nd extension.

c. Huffman coding scheme with 3rd extension.

8. Use Shannon-Fano algorithm to develop an efficient code and calculate the average number of bits/message thereof for a set of five messages with probabilities ½, ¼, ⅛, 1/16, and 1/16.

9. A Gaussian channel has bandwidth of 1 MHz and signal-to-noise power spectral density of 105 Hz. Calculate the channel capacity and maximum transfer rate R of information.

10. a) Explain Shannon – Fano coding algorithm.

b) Apply Shannon fano algorithm to messages with probabilities 0.1,0.2,0.3 and 0.4 and find code efficiency and redundancy ;(2) Calculate the probabilities of 0's and 1's in the code.

11. Using Huffmann coding algorithm, deduce a binary code for a five source symbols of the alphabet of a discrete memoryless source with probabilities 0.4,0.2,0.2 ,0.1 and 0.1. Also calculate the average code word length and efficiency.

12. Explain coding efficiency and redundancy?

13. What is optimum Huffmann coding?

14. Differentiate between Huffmann and optimum Huffmann coding?

MODULE 3

1. Find the channel matrix of the resultant channel. Find P(z1) if P(x1)= 0.6 and P(x2)= 0.4

2. 15000 samples are transmitted per second.

I. Find the rate of information transmitted in the system.
II. Find the max channel capacity of the system.

3. A voice graded channel of the telephone network has a bandwidth of 3.4 kHz.
   a. Calculate the information capacity of the telephone channel for a signal to noise ratio of 30dB.
   b. Calculate the minimum signal to noise ratio required to support information transmission through the telephone channel at the rate of 9600b/s.

4. Alphanumeric data are entered into a computer from a remote terminal through a voice graded telephone channel. The channel has a bandwidth of 3.4 kHz and output signal to noise ratio of 20 dB. The terminal has a total of 128 symbols. Assume that the symbols are equiprobable and successive transmissions are statically independent.
   a. Calculate the information capacity of the channel.
   b. Calculate the maximum symbol rate for which error free transmission over the channel is possible.

5. A black and white television picture may be viewed as consisting of approximately 3 X 105 elements, each of which may occupy one of the 10 distinct brightness levels with equal probability. Assume that the rate of transmission is 30 picture frames per second, and the signal to noise ratio is 30 dB.

6. Using the information capacity theorem, calculate the minimum bandwidth required to support the transmission of the resulting video signal.

7. State and explain Shannon's 1st ,2nd and 3rd theorems.

8. Compute the channel capacity for the channel matrix shown and compute $p(x_i)$ and check if they are realizable.

5. Explain mutual information and prove that the mutual information of a channel is symmetric.

MODULE 4

1. Give the concepts of groups and fields.

2. What is binary field arithmetic?

3. Explain the construction of Galois field.

4. Consider the (7, 4) Hamming code defined by the generator polynomial g(x) = 1+x+x3. The code word 1000101 is sent over a noisy channel, producing the received word 0000101 that has a single error. Determine the syndrome polynomial s(x) for this received word. Find its corresponding message vector m and express m in polynomial m(x).

5. Explain the advantages of cyclic codes over linear block codes?
6. What is parity check matrix of a linear block codes?
7. Discuss on the error detection and error correction capabilities of linear block codes?
8. Differentiate systematic and Unsystematic codes?
9. (i) Prove that the minimum distance of a linear block code is equal to minimum Hamming weight of a nonzero code vector.
   (ii) Explain the process of encoding for a (n,k) cyclic code using shift registers.

10. a) Explain the general form of decoder for cyclic codes.
    c. For a systematic (6,3) linear block code, the parity check matrix 'P' is given as

Find all possible code vectors.

11. Given a generator matrix G = [1,1,1,1] construct a (5,1) code. How many errors can this code correct? Find the code word for the data vector d=0 and d=1?

12. Find a generator matrix G for a (15, 11) single error correcting linear block code. Find the code word for the data vector 10111010101.

MODULE 5

1. Consider a (7, 4) cyclic code with generator polynomial $g(x) = 1+x+x^3$. Let data d= (1010). Find the corresponding systematic code word.

2. Determine the encoded message for the following 8- bit data codes using the CRC generating polynomial $g(x) = x^4+x^3+x^0$. (a) 11001100 (b) 01011111.

3. Construct a convolutional encoder for the following specifications: rate efficiency ½, constraint length 3, the connections from the shift register to modulo – 2 adder are described by the following equations, $g1(x) =1+x+x^2$, $g2(x)=1+x^2$.Determine the output codeword for the message [10011].

4. Explain the Turbo Decoding in detail.

5. A convolution encoder has a single shift register with 2 stages, 3 mod-2 adders and an output Mux. The generator sequence of the encoder as follows: g(1)=(1,0,1), g(2)=(1,1,0) g(3)=(1,1,1). Draw the block diagram and encode the message sequence (1110) and also draw the state diagram.

6. Explain the advantageous of cyclic codes over linear block codes?

7. a) Explain systematic Encoding of (n,k) cyclic codes using n-k shift registers.
   c. Draw the syndrome computation circuit for a single error correcting (7, 4) BCH code and explain its operation?

8. Consider the (31,15) Reed Solomon code:
   (a) How many bits are there in a symbol of the code?
   (b) What is the block length in bits?
   (c) What is the minimum distance of the code?
   (d) How many symbols in error can the code correct?
   (e) What is the length of an in phase burst that the code can correct?

9. Explain the decoding pr0cedure for BCH codes. Draw the syndrome computation circuit for a single correcting (7,4) BCH codes and explain the operation.

10. (i) Prove that the minimum distance of a linear block code is equal to minimum Hamming weight of a nonzero code vector.
    (ii) Explain the process of encoding for a (n,k) cyclic code using shift registers.
11. Explain the general form of decoder for cyclic codes.
12. Explain briefly the syndrome calculation circuit for (n,k) cyclic codes?

MODULE 6

1. Explain Viterby algorithm.

2. (i) What is interleaved convolutional code? Explain.

(ii) Explain the working of (2,1,3) convolutional encoder using transform domain approach?

3. Explain CIRC Encoding.

4. Explain sequential decoding.
5. Explain how convolutional codes are different from block codes.
6. Distinguish between algebraic codes and convolutional codes?
7. (a) Explain the working of (2,1,3) convolutional encoder using transform domain approach.
   (b) Explain Sequential decoding.
8. Explain the maximum likelihood decoding and viterbi decoding algorithms of a convolution encoder.
9. Describe about block and Convolutional interleaving.

10. Consider (3,1,2) convolutional code with g(1) = (110), g(2) = (101) and g(3) = (111):

i. Draw the encoder block diagram.
ii. Find the generator matrix.
iii. Find the code word corresponding to the information sequence (11101) using time domain approach.

11. Construct a convolutional encoder for the following specifications: rate efficiency ½, constraint length 3, the connections from the shift register to modulo – 2 adder are described by the following equations, g1(x) =1+x+x2, g2(x)=1+x2.Determine the output codeword for the message [10011].

12. Explain the Turbo Decoding in detail.
13. A convolution encoder has a single shift register with 2 stages, 3 mod-2 adders and an output Mux. The generator sequence of the encoder as follows: g(1)=(1,0,1), g(2)=(1,1,0) g(3)=(1,1,1). Draw the block diagram and encode the message sequence (1110) and also draw the state diagram.

14. Draw the state diagram, tree diagram and trellis diagram of a (2,1,4) convolution code

EC 403

MICROWAVE ABD RADAR ENGG

COURSE INFORMATION SHEET

PROGRAMME: UG PROGRAMME IN ELECTRONICS & COMMUNICATION ENGINEERING	DEGREE: BTECH
COURSE: MICROWAVE & RADAR ENGINEERING	SEMESTER: VII CREDITS: 3
COURSE CODE: EC 403 REGULATION: 2015	COURSE TYPE: CORE
COURSE AREA/DOMAIN: COMMUNICATION	CONTACT HOURS: 3+1 (Tutorial) hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): EC 431	LAB COURSE NAME:COMMUNICATION SYSTEMS LAB [OPTICAL & MICROWAVE]

SYLLABUS:

UNIT	DETAILS	HOURS
I	**Microwaves:** Introduction, advantages, Cavity Resonators - Rectangular and Circular wave guide resonators- Derivation of resonance frequency of Rectangular cavity. **Microwave vacuum type amplifiers and sources:** Klystron Amplifiers - Re-entrant cavities, Velocity modulation, Bunching (including analysis), Output power and beam loading.	8
II	**Reflex Klystron Oscillators**: Derivation of Power output, efficiency and admittance. **Magnetron oscillators**: Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.	5
III	**Travelling Wave Tube**: Slow wave structures, Helix TWT, Amplification process, Derivation of convection current, axial electric field, wave modes and gain. **Microwave measurements:** Measurement of impedance, frequency and power	6
IV	**Microwave hybrid circuits**: Scattering parameters, Waveguide tees- Magic tees, Hybrid rings, Corners, Bends, and Twists. Formulation of S-matrix.	9

	Directional couplers: Two hole directional couplers, S-matrix of a directional coupler. Circulators and isolators.	
V	**Solid state microwave devices**: Microwave bipolar transistors, Physical structures, Power frequency limitations equivalent circuit. Principle of **Tunnel diodes** and tunnel diode oscillators. **Gunn diodes**: Different modes, Principle of operation Gunn Diode Oscillators.	6
VI	**Radar**: The simple Radar equation. Pulse Radar, CW Radar, CW Radar with non zero IF, Equation for doppler frequency FM-CW Radar using sideband super heterodyne receiver. **MTI Radar**-Delay line canceller, MTI Radar with power amplifier & power oscillator, Non coherent MTI Radar, Pulse Doppler Radar **Radar Transmitters**: Radar Modulator-Block diagram, **Radar receivers**- noise figure, low noise front ends, Mixers, Radar	8
TOTAL HOURS		42

Text Books:

1. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
2. Merrill I. Skolnik, Introduction to Radar Systems, 3/e, Tata McGraw Hill , 2008.

References:

1. Das -Microwave Engineering , 3e, McGraw Hill Education India Education , 2014
2. Kulkarni M, Microwave and Radar Engineering, 4/e, Umesh Publications, 2012.
3. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.
4. Rao, Microwave Engineering, 2/e, PHI, 2012.
5. David M. Pozar , Microwave Engineering,4/e, Wiley India, 2012.
6. Nagaraja N. S., Elements of Electronic Navigation, 2/e, Tata McGraw Hill, 2001.
7. Roy and Mitra, Microwave Semiconductor Devices, PHI, 2013.
8. Raju G. S. N., Microwave Engineering, I.K. International, 2008
9. Vasuki, Microwave Engineering 1e, McGraw Hill Education India, 2015

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
EC303	Applied Electromagnetic Theory	Basics of Waveguides	V
EC306	Antenna & Wave Propagation	Basics of Wave propagation	VI

COURSE OBJECTIVES:

1	To study the various microwave sources, their principle of operation and measurement of various parameters.
2	To study the various microwave hybrid circuits and formulate their S matrices.
3	To understand the basic concepts ,types ,working of radar and introduce to radar transmitters and receivers.

COURSE OUTCOMES:

S NO	DESCRIPTION
1	Students will Acquire knowledge about the characteristics of microwaves, Cavity resonators and Klystron amplifiers.
2	Microwave tubes such as reflex klystrons and magnetron oscillators are studied
3	Will have an idea about TWT, various measurement techniques for MW parameters such as power, impedance and frequency.
4	Students will be able to understand the basics of various hybrid circuits ,Directional couplers and scattering parameters with S matrix formulation.
5	Knows the basic theory of operation of microwave transistor, Tunnel Diodes and Gunn Diodes.
6	The students are introduced about the concept of various types of radar systems.

CO-PO-PSO MAPPING:

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2									3	2	

2	2	3	2	3									2	1	
3	3	3	3	2					1				3	3	
4	3	3	3	3					1				3	3	
5	2	3	3	2									3	2	
6	2	3	3	2		2				2		2	2	1	2
EC 403	**2.5**	**3**	**2.8**	**2.3**		**2**			**1**	**2**		**2**	**2.6**	**2**	**2**

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE ABOVE.

	PO1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	Principle of operation of MW tubes like klystron amplifier etc	Output power and efficiency calculation	Resonant freq derivation for rectangular cavity Resonator.	Design of klystron amplifiers									Analysis of bunching process in klystron amplifier	Design of MW sources	
CO2	Principle of operation of MW tubes like reflex klystron oscillator etc	Analysis of MW tubes like reflex klystron and magnetron oscillator etc	Design of MW oscillators	Analysis of Oscillators power outpour and efficiency									Design and implementation of mw active devices Based on Power output and efficiency.	Reflex klystron characteristics power o/p versus frequency obained by conducting expt.	

CO3	Study of MW TWT and measurement of MW parameter	Analysis of MW semiconductor devices	Design of semiconductor devices for efficient MW commn system	Analysis of TED'S and avanlache transit time devies					Individual and group assignments in various MW parameter mesurements				Design and implementation of MW receiver using parameter measurements	Conduct experiment such as various measurements using bench set up.	
CO4	Micro wave hybrid circuits, scattering parameters calculation	Identify and formulate the S-Matrix for various passive devices such as waveguide tee junctions and directional couplers	Introduction of non reciprocal devices such as isolator and circulator	Analysis of various passive MW devices					Individual and group assignments in S matrix calculation for passive devices				Design and implementation of passive devices using scattering parameters.	Conduct experiments using various devices such as directional coupler ,isolator in a proper bench set up to measure MW parameter.	
CO5	Basic principle of operation of solid state devices	Analysis of various solid state devices such as transistor, tunnel diode and gunn diode	Designof MW oscillators using tunnel , gunn diode for efficient MW commn system	Designing experiments such as gunn charateristics and tunnel diode characteristics									Design of MW circuits using MW solid state devices such as tunnel diode and gunn diode	Design of MW system using tunnel or gunn diode as a source	

CO6	Basics of Radar equation	Analysis of CW radar and MTI radar	Design of Radar transmitter and receiver	Design experiments related to radar modulator, Mixers etc		Radar concepts and design aspects is used to implement social relevent projects for military and commerical purposes.						Design of Radar system using the basics of radar concepts	Analysis of radar system by conducting suitable experiments	Implement social releveant projects using basic concepts of radar

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSED ACTIONS
1	Matching networks	ASSIGNMENT
2	Waveguides-E plane, H Plane	LECTURE
3	Microwave Amplifier design	ASSIGNMENT

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS:

Sl. No.	DESCRIPTION
1	Microwave mixers such as single-ended diode mixer, balanced mixer etc

2	Microwave filters

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION
1	Filter design by image parameter method
2	Filter transformations
3	Microwave oscillator design and analysis
4	Microwave amplifier design and analysis

WEB SOURCE REFERENCES:

1	nptel.iitm.ac.in
2	ocw.mit.edu
3	www.**utexas**.edu

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK	☐ STUD. ASSIGNMENT	☐ WEB RESOURCES	
☐ LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT [Append details of assessment methodologies actually employed (including design and analysis assessment) in spreadsheet format after the completion of each semester]

☐ ASSIGNMENTS	☐ STUD. SEMINARS	☐ TESTS/MODEL EXAMS	☐ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by **Approved by**

Ms.Preethi Bhaskaran

Ms.Rinju Mariam Rolly **Dr.Rithu James**

(Faculty) **(HOD)**

COURSE PLAN

UNIT	DETAILS	HOURS
I	**Microwaves:** Introduction, advantages, Cavity Resonators - Rectangular and Circular wave guide resonators- Derivation of resonance frequency of Rectangular cavity. **Microwave vacuum type amplifiers and sources:** Klystron Amplifiers - Re-entrant cavities, Velocity modulation, Bunching (including analysis), Output power and beam loading.	8
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TOTAL HOURS		42

SAMPLE QUESTION

Module-I

1. Define microwave.
2. Enumerate the basic advantage of microwaves.
3. Derive the resonant frequency of rectangular cavity resonator.
4. What is circular waveguide resonator? Explain.
5. With neat diagram explain the principle of operation of Klystron amplifier.
6. Give short notes on Re-entrant cavities.
7. Explain velocity modulation process in Klystron amplifier with necessary derivation.
8. Derive output power, efficiency and mutual conductance of a klystron amplifier.
9. Define bunching.
10. What do you meant by applegate diagram?

Module-II

1. What are slow wave structures?
2. Explain the working of helix TWT
3. Explain the amplification process of TWT.
4. Derive the convention current of Helix TWT
5. Explain the wave modes of Helix TWT
6. Explain the methods for measurement of impedance
7. Explain the methods for measurement of frequency
8. Explain the methods for measurement of power
9. Explain the different slow wave structures
10. Explain the axial electric field component in TWTs.

Module-III

1. What is S matrix?

Semester VII, Course Hand-Out
Department of EC, RSET 35

2. What are waveguide tees.
3. Explain the properties of magic tees
4. Derive the S matrix of Magic Tee
5. What are hybrid rings?
6. Explain the difference between corners, bends & twists
7. Explain the methods to formulate S matrix
8. Explain the concept of 2 hole directional coupler
9. Derive the S matrix of 2 hole directional coupler
10. Explain the difference between circulators & isolators

Module- IV

1. State and explain the properties of S-parameters.
2. Write the applications of magic tee.
3. Explain the operation of magic tee and derive the scattering matrix for it.
4. Write the properties of magic tee.
5. Explain the construction working and application of isolator based on Faraday rotation.
6. Explain the construction and working of four port circulator with reference to Faraday rotation principle.
7. Define directivity of directional coupler.
8. Describe in detail the operation of a 2-hole directional coupler.
9. What is hybrid ring?
10. Why bends are used?

11. Name some uses of waveguide twists.

Module-V

1. What are the advantages of microwave transistors?
2. Name the surface geometries available in microwave power transistors.
3. Explain the power frequency limitations of transistor.
4. Describe tunneling phenomenon.
5. What are the various modes of operation of Gunn diode?
6. Explain the construction and working of tunnel diode.
7. Write advantages and applications of tunnel diode.
8. Describe the modes of operation for Gunn diode?
9. Explain the principle of operation Gunn diode oscillator.
10. What is –ive resistance in Gunn diode?

Module-VI

1. Draw the block diagram of Pulsed radar and explain its operation.
2. Derive basic radar's equation.
3. Explain the operation of CW radar with neat block diagram
4. Differentiate the operation of pulse radar from simple CW radar.
Semester VII, Course Hand-Out
Department of EC, RSET 36
5. Draw the block diagram of non coherent MTI radar and explain the function of each block in detail.
6. Explain the advantages of non coherent MTI Radar.
7. A simple MTI delay line canceller is an example of time domain filter .Why? Explain.
8. Explain the principle and working of MTI radar with neat block diagram.
9. With the help of neat block diagram, explain the power amplifier type MTI Radar.
10. Write short notes on Pulse Doppler Radar.

EC 405

OPTICAL COMMUNICATION

COURSE INFORMATION SHEET

PROGRAMME: OPTICAL COMMUNICATION	DEGREE: BTECH
COURSE: Light Wave Communication	SEMESTER: S7 CREDITS: 3
COURSE CODE: EC405 REGULATION:2016	COURSE TYPE: **CORE** /ELECTIVE / BREADTH/ S&H
COURSE AREA/DOMAIN: Optics	CONTACT HOURS: 3-0-0 (Tutorial) hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): EC 431	LAB COURSE NAME: COMMUNICATION SYSTEMS LAB (OPTICAL & MICROWAVE)

SYLLABUS:

UNIT	DETAILS	HOURS
I	General light wave system, advantages, classification of light wave systems. Fibres: types and refractive index profiles, mode theory of fibres: modes in SI and GI fibres, linear and non linear effects in fibres, dispersion, Group Velocity Dispersion, modal, wave guide and Polarization,Modes, Dispersion, Attenuation - absorption, bending and scattering losses.	8
II	Fibre materials, fabrication of fibres, photonic crystal fibre, index guiding PCF, photonic bandgap fibre, fibre cables. Optical sources, LEDs and LDs, structures, characteristics,modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications	7
III	Optical detectors, types and characteristics, structure and working of PIN and AP, noise in detectors, comparison of performance. Optical receivers, Ideal photo receiver and quantum limit of detection.	6
IV	Digital transmission systems, design of IMDD links- power and rise time budgets, coherent Systems, sensitivity of a coherent receiver, comparison with IMDD systems. Introduction to soliton transmission, soliton links using optical amplifiers, GH effect, soliton-soliton interaction, amplifier gain fluctuations, and design guide lines of soliton based links.	8
V	Optical Amplifiers ,basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working,Semiconductor laser amplifier, Raman amplifiers, TDFA,amplifier configurations, performance comparison.	6
VI	The WDM concept, WDM standards, WDM components,couplers, splitters, Add/ Drop multiplexers, gratings, tunable filters, system performance parameters. Introduction to optical networks. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection, length and refractive index measurements.	7
	TOTAL HOURS	42

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	Gerd Keiser: Optical Fiber Communications,5/e,McGraw Hill, 2013.

2	Mishra and Ugale,Fiberoptic Communication, Wiley ,2013.
3	Chakrabarthi, Optical Fibre Communication, McGraw Hill, 2015.
4	Hebbar, Optical fibre communication, Elsevier, 2014
5	John M Senior- Optical communications, **3/e**, Pearson, 2009.
6	Joseph C. Palais, Fibre Optic Communications, 5/e Pearson, 2013.
7	Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
EC203 EC205	Solid State Devices Electronic Circuits	Should have knowledge of Basic principles of Optics and ray theory	**7**

COURSE OBJECTIVES:

1	To introduce the concepts of light transmission through optical fibers, optical sources and detectors
2	To compare the performance of various optical transmission schemes.
3	To impart the working of optical components and the principle of operation of optical amplifiers.
4	To give idea on WDM technique.

COURSE OUTCOMES:

SNO	DESCRIPTION
1	Know about light transmission through optical fibers and concept of attenuation and dispersion
2	Understand the construction and working of Optical sources- LEDs and LASERs
3	Understand the characteristics of Optical detectors
4	Design and analysis of Optical networks and Optical fiber link design
5	Apply the knowledge of optical amplifiers in the design of optical link & Analyse the performance of optical amplifiers.
6	Describe the principle of FSO,VLC and LiFi & Know the concept of WDM & optical network components

CO mapping with PO, PSO

	PO1	PO2	PO3	PO5	PO6	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	2	3		2	2	
CO2	1	2	2	1	2		2		
CO3	3	2	2	1	1		3		
CO4	2	2	2			1	3		

CO5	3	3	3	2		1	3	3	2
CO6	2	2	3	2		1	2	3	2
EC405	3	2	2	2	1	1	2	2	1

	PO1	PO2	PO3	PO5	PO6	PO12	PSO1	PSO2	PSO3
CO1	Basics of Ray optics requires adequate knowledge in basic science, mathematics and engineering fundamentals	Knowledge of optics to understand fiber propagation	The solutions for optical communication problems requires better understanding of electromagnetic theory	Optical signal processing needs more research for effective decoding of information	Design of optical systems requires advanced tools which can deal with optical domain		Optical system requires devices which can handle both analog and digital information	Optical ssystems needs the usage of tools like Optisystem, etc	

CO2	Students get the ability to demonstrate modern tools for understanding functionality of optical devices	Students understand the mechanism to implement coding & decoding techniques	Appropriate tools knowledge can be used for deep investigation of complex problems	Students gains the ability to identify, formulate and analyze engineering problem	Design of efficient system require advanced tools which can deal with digital systems		provide a platform to demonstrate their practical skills		
CO3	Students get the ability to demonstrate modern tools	Students understand the mechanism to implement coding & decoding techniques	Appropriate tools knowledge can be used for deep investigation of complex problems	Students gains the ability to identify, formulate and analyze engineering problem	Design of efficient system require advanced tools which can deal with digital systems		provide a platform to demonstrate their programming skills		
CO4	System design needs deep knowledge in basic science disciplines	Optical system design needs deep knowledge in mathematics and basic science disciplines	Equipments used for communication applications needs to be compatible with existing systems			Ability to engage in lifelong learning in the broadest of technological	Optical system selection plays a vital role in any communication		

						change	system development.		
CO5	Optical link design considerations	identify the types of various losses for calculating power budget and link budget	Introduction of optical fiber link design	Analysis of various optical networks used in various applications		Ability to engage in lifelong learning in the broadest of technological change	Design and implementation of optical communication system using optisystem etc.	Conduct experiment such as various measurements using optical bench set up.	Implementation of social relevant projects using the basics of measurement concepts
CO6	To give idea on WDM technique	Know different WDM network components	Introduction to Photonic switching	Analysis of various optical networks used in various applications		Ability to engage in lifelong learning in the broadest of technological change	Design and implementation of optical communication system using optisystem etc.	Conduct experiment such as various measurements using optical bench set up.	Implementation of social relevant projects using the basics of measurement concepts

GAPES IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS
1	Optical based Lab Experiments	
2	Assignments & Breadboard Demonstration	
3	Group activity	

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

1	• Use of simulation tools like optisystem, light runner etc for understanding the concepts related to optical communication

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION
1	Understanding responses of optical devices and design considerations in optisystem software
2	MZI implementation in Optisystem software

WEB SOURCE REFERENCES:

1	www.nptel.iit.a.c.in
2	www.slideshare.net

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☑ WEB RESOURCES	
☐ LCD/SMART BOARDS	☑ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☑ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
☑ STUD. LAB PRACTICES	☐ STUD. VIVA	☑ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (TWICE)

☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by
Deepthi G. S

Approved

(HOD)

COURSE PLAN

UNIT	DETAILS	HOURS
I	General light wave system, advantages, classification of light wave systems. Fibres: types and refractive index profiles, mode theory of fibres: modes in SI and GI fibres, linear and non linear effects in fibres, dispersion, Group Velocity Dispersion, modal, wave guide and Polarization,Modes, Dispersion, Attenuation - absorption, bending and scattering losses.	8
II	Fibre materials, fabrication of fibres, photonic crystal fibre, index guiding PCF, photonic bandgap fibre, fibre cables. Optical sources, LEDs and LDs, structures, characteristics,modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications	7
III	Optical detectors, types and characteristics, structure and working of PIN and AP, noise in detectors, comparison of performance. Optical receivers, Ideal photo receiver and quantum limit of detection.	6
IV	Digital transmission systems, design of IMDD links- power and rise time budgets, coherent Systems, sensitivity of a coherent receiver, comparison with IMDD systems. Introduction to soliton transmission, soliton links using optical amplifiers, GH effect, soliton-soliton interaction, amplifier gain fluctuations, and design guide lines of soliton based links.	8
V	Optical Amplifiers ,basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working,Semiconductor laser amplifier, Raman amplifiers, TDFA,amplifier configurations, performance comparison.	6
VI	The WDM concept, WDM standards, WDM components,couplers, splitters, Add/ Drop multiplexers, gratings, tunable filters, system performance parameters. Introduction to optical networks. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection, length and refractive index measurements.	7
TOTAL HOURS	42	

SAMPLE QUESTION

MODULE I

- A multimode fiber with 50 micrometer core diameter is designed to limit the intermodal dispersion to 10ns./km. What is the numerical aperture of this fiber?
- What is the limiting bit rate for transmission over 10km at 0,88 micrometer. Let the refractive index of core be 1.45.Also find the number of modes supported.
- What do you mean by numerical aperture. Write an expression for that.
- Describe an optical fiber communication system with a block diagram
- Describe the intermodal and intramodal dispersion in optical fiber.
- How we can classify optical fibers in accordance with refractive index profile?
- What is dispersion? Explain the different types of dispersion .Why single mode fiber are used in commercial communication systems?

MODULE II

- What do you mean by modes in a laser diode? Explain.
- Explain the different types of scattering losses.
- What is Amplifier Spontaneous Emission Noise?

MODULE III

- Compare Avalanche photodiode and PIN photodiode.
- Define responsivity of photodiode.Photons of energy 1.53x10-19 J are incident ona photodiode which has a responsivity of 0.65 A/W.If the optical power level is 10μW,find the photocurrent generated.
- Explain the terms responsivity and quantum efficiency of a photodetector.
- With suitable diagrams explain operation of PIN and APD.
- An APD has quantum efficiency of 45% at 0.85μm. When illuminated with radiation of wavelength it produces an output photocurrent of 10μA after avalanche gain with a multiplication factor of 250.Calculate the received optical power to the device.
- List the requirements of a photodetector
- What are the different sources of noise in photodetectors
- Define noise equivalent power and detectivity of photodetector.
- Draw and explainavalanche photodiode structures and electric field in depletion and multiplication region.Also explain avalanche multiplication noise.
- Draw the equivalent circuit of an optical receiver and explain the related terms. With the help of necessary figures, describe the working of an IMDD system.

MODULE IV

- What is Gordon Haus effect?
- Describe the design of IMDD links
- Describe about the sensitivity of a coherent receiver
- Compare quantum efficiency and responsivity of pin diode.
- Write the basic concept of soliton generation, and also write the advantages of soliton based communication system

MODULE V1

- Explain thebasic concept of optical amplifiers
- What are the different types optical amplifiers
- What are the advantages of semiconductor optical amplifier
- Explain the different possible applications of optical amplifiers in a practical optical communication system.
- Explain how amplification mechanism takes place in EDFA amplifiers6Explain Raman amplifiers
- Briefly describe the TDFA amplifier
- What are optical Amplifiers? Explain the Working any two with neat diagrams.
- What are the advantages of SOA over EDFA?10What is a grating? A plain transmission grating possesses 5000 rulings /cm.

EC 407

COMPUTER COMMUNICATION

COURSE INFORMATION SHEET

PROGRAMME: ELECTRONICS &COMMUNICATION ENGINEERING	**DEGREE:** BTECH
COURSE: **Computer Communication**	**SEMESTER:** 7 **CREDITS:** 3
COURSE CODE: EC 407 **REGULATION:**2016	**COURSE TYPE:** CORE
COURSEAREA/DOMAIN: Communication Networks	**CONTACT HOURS:** 3+0 (Tutorial) Hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY):NIL	**LAB COURSE NAME:**

SYLLABUS:

UNIT	DETAILS	HOURS
I	Introduction to computer communication: Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication. Switching: circuit switching and packet switching, Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks: Internetwork, Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.	**6**
II	Physical Layer: Guided and unguided transmission media (Co-axial cable, UTP,STP, Fiber optic cable) Data Link Layer: Framing, Flow control (stop and wait , sliding window flow control) Error control, Error detection(check sum, CRC), Bit stuffing, HDLCMedia access control: Ethernet (802.3), CSMA/CD, Logical link control, Wireless LAN (802.11), CSMA/CA	8
III	Network Layer Logical addressing : IPv4 & IPV6,Address Resolution protocols (ARP, RARP) Subnetting, Classless Routing(CIDR), ICMP, IGMP, DHCP, Virtual LAN, Networking devices (Hubs, Bridges & Switches)	8
IV	Routing: Routing and Forwarding, Static routing and Dynamic Routing, Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm) Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), MPLS	6
V	Transport Layer –UDP, TCP, Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control, QoS and Flow Characteristics, Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP, POP3, MIME, SNMP	8
VI	Introduction to information system security, common attacks, Security at Application Layer (E-MAIL, PGP and S/MIME). Security at Transport Layer (SSL and TLS). Security at Network Layer (IPSec). Defence and counter measures: Firewalls and their types. DMZ, Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid IDSs	6
TOTAL HOURS		**42**

TEXT/REFERENCE BOOKS:

1. Behrouz A. Forouzan, Cryptography & Network Security , , IV Edition, Tata McGraw-Hill, 2008
2. J F Kurose and K W Ross, Computer Network A Top-down Approach Featuring the Internet, 3/e, Pearson Education, 2010
3. Behrouz A Forouzan, Data Communications and Networking, 4/e, Tata McGraw-Hill, 2006.
4. Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011.
5. S. Keshav, An Engineering Approach to Computer Networking, Pearson Education, 2005.
6. Achyut S.Godbole, Data Communication and Networking, 2e, McGraw Hill Education New Delhi, 2011

COURSE PRE-REQUISITES:

Sl.No	COURSE NAME	DESCRIPTION	SEM
1	EC206 Computer Organization	Basic knowledge of preliminary subjects.	S4

COURSE OBJECTIVES:

The students will have a thorough understanding of:
i. Different types of network topologies and protocols.
ii. The layers of the OSI model and TCP/IP with their functions.
iii. The concept of subnetting and routing mechanisms.
iv. The basic protocols of computer networks, and how they can be used to assist in network design and implementation.
v. Security aspects in designing a trusted computer communication system

COURSE OUTCOMES:

Sl. No.	DESCRIPTION
EC407.1	Ability to Different types of network topologies and protocols.
EC407.2	Ability to understand the layers of the OSI model and TCP/IP with their functions
EC407.3	Ability to understand the concept of subnetting and routing mechanisms.
EC407.4	Ability to understand the basic protocols of computer networks
EC407.5	Ability to understand Security aspects in designing a trusted computer communication system

CO-PO-PSO MAPPING:

CO-PO-PSO MAPPING:

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	3	1	-	-	-	-	-	-	-	-	2	1	-	-
2	2	3	1	-	-	-	-	-	-	-	-	2	1	-	-

3	2	3	1	-	-	-	-	-	-	-	-	2	1	-	-
4	-	-	3	2	-	-	-	-	-	-	-	-	2	-	-
5	3	3	3	2	-	-	-	-	-	-	-	2	1	-	-
EC 407	**2.2**	**3**	**1.8**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1.2**	**-**	**-**

Justification

	PO1	PO2	PO3	PO4	PO12	PSO1
CO 1	Students will acquire the knowledge of communication networks and analyze networking problems	Identify, formulate, review and analyze complex network problems reaching substantiated conclusions by understanding these concepts	Design solutions for complex network problems with appropriate consideration for culture and society		Understanding of the given outcome enables student to learn further about the upcoming protocols	demonstrate skills in testing networking circuits and systems
CO 2	Students will be able to apply knowledge of LAN and multiple access to solve networking problems	Using the acquired knowledge identify, formulate, review and analyze complex network problems reaching conclusions	Design solutions for complex network problems with appropriate consideration for culture and society		Understanding of the given outcome enables student to learn further about the modern and yet to come multiple access method	demonstrate skills in testing networking circuits and systems
CO 3	Students will be able to apply knowledge of IP to solve networking problems	Using the acquired knowledge identify, formulate, review and analyze complex network problems reaching conclusions	Design solutions for complex network problems with appropriate consideration for culture and society		Understanding of the given outcome enables student to learn further about the modern versions of IP	demonstrate skills in testing networking circuits and systems
CO 4			Design routing methods and protocols using the acquired	Designing leads to conduct investigations and research		demonstrate skills in designing networking circuits

			knowledge of existing methods	methods to find solutions to the method		and systems
CO 5					Understanding of the given outcome enables student to learn further about the changing trends in cryptography	demonstrate skills in testing and designing security protocols at different levels

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSEDACTIONS
1	Network Simulator	Tool discussion
2		
3		
4		
5		

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SNO	DESCRIPTION	PROPOSED ACTIONS
1	Routing algorithms discussion in detail	Extra Class
2		
3		
4		

WEB SOURCE REFERENCES:

Sl. No.	DESCRIPTION
1	http://www.isi.edu/nsnam/ns/tutorial/
2	http://nptel.iitm.ac.in

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK✓	☐ STUD. ASSIGNMENT✓	☐ WEB RESOURCES	☐ LCD/SMART BOARDS
☐ STUD. SEMINARS	☐ ADD-ON COURSES		

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS✓	☐ STUD. SEMINARS	☐ TESTS/MODEL EXAMS✓	☐UNIV. EXAMINATION✓

☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)✓	☐ STUDENT FEEDBACK ON FACULTY (TWICE)✓
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by

Tressa Michael,Dr.Anand S,Naveen N

(Faculty)

Approved by
Dr. Rithu James

(HOD)

COURSE PLAN

UNIT	DETAILS	HOURS
I	Introduction to computer communication: Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication. Switching: circuit switching and packet switching, Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks: Internetwork, Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.	**6**
II	Physical Layer: Guided and unguided transmission media (Co-axial cable, UTP,STP, Fiber optic cable) Data Link Layer: Framing, Flow control (stop and wait , sliding window flow control) Error control, Error detection(check sum, CRC), Bit stuffing, HDLCMedia access control: Ethernet (802.3), CSMA/CD, Logical link control, Wireless LAN (802.11), CSMA/CA	8
III	Network Layer Logical addressing : IPv4 & IPV6,Address Resolution protocols (ARP, RARP) Subnetting, Classless Routing(CIDR), ICMP, IGMP, DHCP, Virtual LAN, Networking devices (Hubs, Bridges & Switches)	8
IV	Routing: Routing and Forwarding, Static routing and Dynamic Routing, Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm) Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), MPLS	6
V	Transport Layer –UDP, TCP, Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control, QoS and Flow Characteristics, Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP, POP3, MIME, SNMP	8
VI	Introduction to information system security, common attacks, Security at Application Layer (E-MAIL, PGP and S/MIME). Security at Transport Layer (SSL and TLS). Security at Network Layer (IPSec). Defence and counter measures: Firewalls and their types. DMZ, Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid IDSs	6
TOTAL HOURS		**42**

SAMPLE QUESTION

Module 1

- Explain the Transmission modes.
- Differentiate serial and parallel communication.
- Which are the different types of serial communication?
- What are the important criterion for networking?

Module 2

- Explain the different layers in the networking
- What is Guided and unguided transmission media?
- What is bit stuffing?
- Explain HDLC
- Write short note on a. Ethernet (802.3) b. CSMA/CD c. Logical link control d. Wireless LAN (802.11) e. CSMA/CA

Module 3

- Explain IPv4 & IPV6
- Give short note on Address Resolution protocols (ARP, RARP)
- What is Subnetting?
- Explain the different Classless Routing
- Explain the various Networking devices

Module 4

- What is Routing?
- What is Forwarding?
- Differentiate Static routing and Dynamic routing
- Explain the various Routing Algorithms:
- Explain the Routing Protocols: a. Routing Information protocol (RIP), b. Open Shortest Path First (OSPF), c. Border Gateway Protocol (BGP), d. MPLS

Module 5

- Explain the Transport Layer.
- Differentiate UDP and TCP
- What is Congestion Control?
- What are the characteristics of flow?
- What is QoS?
- Write short note on a. DNS b. Remote Logging (Telnet) c. SMTP, d. FTP e. WWW, f. HTTP

Module 6

- Explain the Security at Application Layer.
- Explain the Security at Network Layer (IPSec).
- What are the Defence and counter measures?
- What are Firewalls and which are their types?
- Explain the Intrusion Detection Systems.

EC 409

CONTROL SYSTEM

COURSE INFORMATION SHEET

PROGRAMME: ELECTRONICS AND COMMUNICATION ENGINEERING	DEGREE: B.TECH
COURSE: CONTROL SYSTEMS	SEMESTER: 7 CREDITS: 3
COURSE CODE: EC409 REGULATION: 2016	COURSE TYPE: CORE
COURSE AREA/DOMAIN: CONTROL SYSTEMS	CONTACT HOURS: 3 hours /Week.
CORRESPONDING LAB COURSE CODE (IF ANY): NIL	LAB COURSE NAME: NA

SYLLABUS:

UNIT	DETAILS	HOURS
I	Basic Components of a Control System, Applications, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system. Effects of Feedback on Overall Gain, Stability, External, disturbance or Noise. Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems. Overview of solving differential equations using Laplace transforms. Mathematical modelling of control systems - Electrical Systems and Mechanical systems. Block diagram representation and reduction methods. Signal flow graph and Mason's rule formula.	10
II	Standard test signals. Time response specifications. Time response of first and second order systems to unit step input, ramp inputs, time domain specifications. Steady state error and static error coefficients. Dynamic error coefficient.	5
III	Stability of linear control systems: methods of determining stability, Routh's Hurwitz Criterion. Root Locus Technique: Introduction, properties and its construction. Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	5
IV	Nyquist stability criterion: fundamentals and analysis. Relative stability: gain margin and phase margin. Stability analysis with Bode plot. Design of Control Systems: PI,PD and PID controllers. Design with phase-lead and phase-lag controllers (frequency domain approach), Lag-lead.	8
V	State variable analysis: state equation, state space representation of Continuous Time systems. Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix. Concepts of Controllability and Observability, Kalman's Test, Gilbert's test.	6

VI	Discrete Control systems fundamentals: Overview of Z transforms. State space representation for Discrete time systems. Sampled Data control systems, Sampling Theorem, Sample & Hold, Open loop & Closed loop sampled data systems. State space analysis : Solving discrete time state space equations, pulse transfer function, Discretization of continuous time state space equations. Stability analysis of discrete time systems Jury's test.	8
	TOTAL HOURS	40

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T	Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
T	Gopal, Control Systems, 4/e, McGraw Hill Education India Education , 2012
T.	Ogata K., Discrete-time Control Systems, 2/e, Pearson Education
R	Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India 2012
R	Norman S. Nise, Control System Engineering, 5/e, Wiley India
R	Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002
R	Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
EC 202	Signals & Systems	Basics of Signals & Systems	IV

COURSE OBJECTIVES:

1	To introduce the elements of control system and its modelling
2	To introduce methods for analyzing the time response, the frequency response and the stability of systems.
3	To design control systems with compensating techniques.
4	To introduce the state variable analysis method.

5	To introduce basic concepts of digital control systems.

COURSE OUTCOMES:

Sl. No.	DESCRIPTION
1	Students will be able to represent systems mathematically and derive their transfer function model.
2	Students will be able to analyse the time response and frequency response of the systems for various input signals
3	Students will be able to determine the stability of system
4	Students will be able to perform state variable analysis of systems
5	Students will be able to analyse a digital control system

CO-PO-PSO MAPPING:

	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1							1	1	1	
2	1	1	1	1	1							1	1	1	
3	1	1	1	1	1							1	1	1	
4	1	1	1		1							1	1	1	
5	1	1	1	1	1							1	1	1	
6	1	1	1	1	1							1	1	1	
	1	**1**	**1**	**1**	**1**							**1**	**1**	**1**	

JUSTIFICATION FOR CO-PO MAPPING

MAPPING	**LEVEL**	**JUSTIFICATION**
C409.1-PO1	1	Knowledge of differential equations, Laplace transforms and basic physics work together for modelling

C409.1-PO2	1	Modelling in itself is a problem analysis
C409.1-PO3	1	Problem is modelling and solution is a transfer function representing the system
C409.1-PO4	1	Modelling pause a complex problem, identifying the required characteristics is important.
C409.1-PO5	1	Matlab can be utilized to verify the final model
C409.2-PO1	1	Analysing a system from different perspective to understand its behavior using the model
C409.2-PO2	1	Kean analysis of response required to completely predict system behavior
C409.2-PO3	1	This CO decides whether the system design meets the required criteria or not.
C409.2-PO5	1	With modern tools generating system response is easier.
C409.3-PO1	1	Understanding stability is the first step to controller design
C409.3-PO2	1	Different system's stability are tested by students
C409.3-PO3	1	The most important criteria is controller design is stability
C409.3-PO4	1	Bringing stability to an unstable system
C409.3-PO5	1	Different plots can be constructed using Matlab to analyse stability
C409.4-PO2	1	Students need to identify and formulate controller requirement and analyse
C409.4-PO3	1	After formulation of problem controller design is done
C409.4-PO5	1	Response analysis and stability check become easier with tools
C409.5-PO1	1	Since most of the control systems are MIMO, state variable representation is frequently used
C409.5-PO2	1	Analysing a system from different perspective to understand its behavior using the model
C409.5-PO3	1	Kean analysis of response required to completely predict system behavior

C409.5-PO4	1	This CO decides whether the system design meets the required criteria or not.
C409.5-PO5	1	Matrix can be better handled with Matlab
C409.6-PO1	1	Z transform comes into the picture

JUSTIFICATION FOR CO-PSO MAPPING

MAPPING	LEVEL	JUSTIFICATION
C409.1-PSO1	1	All the methods studied and skill acquired are directly used in industry
C409.1-PSO2	1	EDA tools such as Matlab plays an important part
C409.2-PSO1	1	Response analysis can be considered as a skill
C409.2-PSO2	1	EDA tools such as Matlab plays an important part
C409.3-PSO1	1	Stability analysis can be considered as a skill
C409.3-PSO2	1	EDA tools such as Matlab plays an important part
C409.4-PSO1	1	Designing and implementation skills are acquired
C409.4-PSO2	1	EDA tools such as Matlab plays an important part

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS
1	Effects of adding poles and zeroes in the transfer function – time domain	Class room teaching
2	Effects of adding poles and zeroes in the transfer function – Frequency domain	Class room teaching

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

1	Design of compensation networks

WEB SOURCE REFERENCES:

1	http://nptel.ac.in/courses/108102043/

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

✓ CHALK & TALK	✓ STUD. ASSIGNMENT	✓ WEB RESOURCES
☐ LCD/SMART BOARDS	✓ STUD. SEMINARS	✓ ADD-ON COURSES

ASSESSMENT METHODOLOGIES-DIRECT

☐-ASSIGNMENTS	☐ ~~STUD. SEMINARS~~	✓ TESTS/MODEL EXAMS	✓ UNIV. EXAMINATION
✓ STUD. LAB PRACTICES	✓ STUD. VIVA	✓ MINI/MAJOR PROJECTS	☐ ~~CERTIFICATIONS~~
☐ ~~ADD-ON COURSES~~	☐ ~~OTHERS~~		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY
☐ ~~ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS~~	☐ ~~OTHERS~~

Prepared by **Approved by**

Aarathi Sankar
Nitheesh Kurian
Neethu Radha Gopan **HOD - ECE**

COURSE PLAN

UNIT	DETAILS	HOURS
I	Basic Components of a Control System, Applications, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system. Effects of Feedback on Overall Gain, Stability, External, disturbance or Noise. Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems. Overview of solving differential equations using Laplace transforms. Mathematical modelling of control systems - Electrical Systems and Mechanical systems. Block diagram representation and reduction methods. Signal flow graph and Mason's rule formula.	10
II	Standard test signals. Time response specifications. Time response of first and second order systems to unit step input, ramp inputs, time domain specifications. Steady state error and static error coefficients. Dynamic error coefficient.	5
III	Stability of linear control systems: methods of determining stability, Routh's Hurwitz Criterion. Root Locus Technique: Introduction, properties and its construction. Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	5
IV	Nyquist stability criterion: fundamentals and analysis. Relative stability: gain margin and phase margin. Stability analysis with Bode plot. Design of Control Systems: PI,PD and PID controllers. Design with phase-lead and phase-lag controllers (frequency domain approach), Lag-lead.	8
V	State variable analysis: state equation, state space representation of Continuous Time systems. Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix. Concepts of Controllability and Observability, Kalman's Test, Gilbert's test.	6
VI	Discrete Control systems fundamentals: Overview of Z transforms. State space representation for Discrete time systems. Sampled Data control systems, Sampling Theorem, Sample & Hold, Open loop & Closed loop sampled data systems. State space analysis : Solving discrete time state space equations, pulse transfer function, Discretization of continuous time state space equations. Stability analysis of discrete time systems Jury's test.	8

SAMPLE QEUSTIONS

MODULE I

1. With the help of a block diagram, explain the basic components in a control system.

List five applications of control systems

3. Differentiate between open-loop and closed-loop control systems

4. Explain the working of a control system, with an example.

5. How does a control system affect the following system performance parameters?

a. Gain

b. Stability

c. Noise

6. How can control systems be classified? Explain.

7. Describe the mathematical modelling of a series RLC circuit.

8. Using an example, demonstrate the mathematical modelling of a mechanical system.

9. Illustrate two techniques used in block diagram reduction.

10. What is a signal flow graph? How is it different from a block diagram?

11. What is Mason's rule? Explain.

MODULE II

1. Define the time response specifications of a system.

2. What is the typical response of a first order system to (a) a unit step input (b) a ramp input?

3. What is the typical response of a second order system to (a) a unit step input (b) a ramp input?

4. What is meant by steady state error?

5. What are static and dynamic error coefficients?

MODULE III

1. What are the different methods by which the stability of a linear control system can be determined?

2. What is Routh-Hurwitz criterion?

3. Explain the Root Locus Technique.

4. What are the frequency domain specifications that characterize a system?

5. What is the correlation between time and frequency responses?

MODULE IV

1. Explain the Nyquist stability criterion

2. What is meant by (a) Gain margin (b) Phase Margin (c) Gain cross-over point (d) Phase crossover frequency?

3. What is meant by Bode plot? Explain.

4. How can the stability of a system be determined from its Bode plot?

5. What is the function of each component in a PID controller?

6. What is a PID controller? What is its advantage over a PI controller?

7. Explain, in detail, the design of a phase-lead controller. Provide an application.

8. Explain, in detail, the design of a phase-lag controller. Provide an application.

9. What is a lag-lead controller? Why is it used?

MODULE V

1. What is meant by state-space representation of a system? What are state variables?

2. How can the transfer function be determined from its state space representation?

3. Define state transition matrix.

4. Define observability and controllability. Explain.

5. What is Kalman's test. Explain.

6. What is Gilbert's test. Explain

EC 467

PATTERN RECOGNITION

COURSE INFORMATION SHEET

PROGRAMME: UG PROGRAMME IN ELECTRONICS & COMMUNICATION ENGINEERING	DEGREE: B. TECH.
COURSE: PATTERN RECOGNITION	SEMESTER: VII CREDITS: 3
COURSE CODE: EC 467 REGULATION: 2015	COURSE TYPE: ELECTIVE
COURSE AREA/DOMAIN: MACHINE LEARNING	CONTACT HOURS: 3 hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): NIL	LAB COURSE NAME:

SYLLABUS:

UNIT	DETAILS	HOURS
I	**Introduction:** Basics of pattern recognition system, various applications, Machine Perception, classification of pattern recognition systems, Design of Pattern recognition system, Pattern recognition Life Cycle, Statistical Pattern Recognition: Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminant functions, Decision surfaces	9
II	Parameter estimation methods: Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation, Concept of feature extraction and dimensionality, Curse of dimensionality, Dimension reduction methods - Fisher discriminant analysis, Principal component analysis Hidden Markov Models (HMM) basic concepts, Gaussian mixture models.	**8**
III	Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification: Non-numeric data or nominal data, Decision trees: Concept of construction, splitting of nodes, choosing of attributes, overfitting, pruning	6
IV	Linear Discriminant based algorithm: Perceptron, Support Vector Machines	5
V	Multilayer perceptrons, Back Propagation algorithm, Artificial Neural networks, Classifier Ensembles: Bagging, Boosting / AdaBoost	6
VI	Unsupervised learning: Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation	5
	TOTAL HOURS	39

TEXT/REFERENCE BOOKS:

T/R	**BOOK TITLE/AUTHORS/PUBLICATION**
1	C M Bishop, Pattern Recognition and Machine Learning, Springer
2	R O Duda, P.E. Hart and D.G. Stork, Pattern Classification and scene analysis, John Wiley
3	Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
4	Robert J. Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches,

	John Wiley & Sons Inc., New York, 2007.
5	S.Theodoridis and K. Koutroumbas, Pattern Recognition, 4/e, Academic Press, 2009.
6	Tom Mitchell, Machine Learning, McGraw-Hill
7	Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

COURSE PRE-REQUISITES:

COURSE CODE	COURSE NAME	DESCRIPTION	SEM
	Nil		

COURSE OBJECTIVES:

Sl. No.	DESCRIPTION
1	To introduce the fundamental algorithms for pattern recognition
2	To instigate the various classification and clustering techniques

COURSE OUTCOMES:

Sl. No.	DESCRIPTION
1	Graduates will be able to understand the basics of pattern recognition systems and statistical pattern recognition.
2	Graduates can learn feature extraction and dimensionality reduction.
3	Graduates can learn decision trees
4	Graduates can analyse perceptrons and support vector machines.
5	Graduates can understand multilayer Networks and back propagation algorithm
6	Graduates can understand clustering

CO-PO-PSO MAPPING:

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3									3	3	3	
CO 2	3	3	3									3	3	3	
CO 3	3	3	3										3		
CO 4	3	3	3										3		
CO 5	3	3	3										3		
CO 6	3	3	3										3		

JUSTIFICATION FOR CO-PO MAPPING

MAPPING	LEVEL	JUSTIFICATION
CO1-PO1	3	Design Pattern Recognition Systems
CO1-PO2	3	Solve problems using Bayes theorem
CO1-PO3	3	To provide solutions for minimum error and minimum risk
CO1-PO12	3	With probability theory, analysis of various classification systems possible
CO2-PO1	3	Analyse probability distributions
CO2-PO2	3	Estimation of parameters
CO2-PO3	3	Dimensionality reduction techniques
CO2-PO12	3	Classification for daily life applications
CO3-PO1	3	Non parametric density estimation
CO3-PO2	3	Analyse histogram estimation
CO3-PO3	3	Design classifier with decision trees
CO4-PO1	3	Analyse linear discriminant based algorithms
CO4-PO2	3	Perceptron algoritms derivation
CO4-PO3	3	Support vector machine algorithm formation
CO5-PO1	3	Anlyse multilayer perceptrons
CO5-PO2	3	Anlyse and derive back propagation algorithm
CO5-PO3	3	Design of adaboost classifiers
CO6-PO1	3	Analyse clustering criterions
CO6-PO2	3	Analysis K means classifier
CO6-PO3	3	Analysis Hierarchical classifiers

JUSTIFICATION FOR CO-PSO MAPPING

MAPPING	LEVEL	JUSTIFICATION
CO1-PSO1	3	Optimal solutions for minimum error classifiers
CO1-PSO2	3	Useful in daily life applications
CO2-PSO1	3	Understand parameter estimation techniques
CO2-PSO2	3	Useful in probability estimations
CO3-PSO1	3	Understand decision trees
CO4-PSO1	3	Understand linear discriminant algorithms
CO5-PSO1	3	Understand multilayer perceptrons
CO6-PSO1	3	Understand clustering criterions

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	Regression	NPTEL course	1,2,3,4
2	Class separability measures	NPTEL course	1,2,3,4

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Context-Dependent Classification	1,2,3,4,5

2	Hard Clustering	1,2,3,4,5

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Classifier design problems	1,2,3,4
2	Linear Regression Algorithms	1,2,3,4
3	Clustering criterions	1,2,3,4

WEB SOURCE REFERENCES:

Sl. No.	DESCRIPTION
1	http://nptel.ac.in
2.	https:/www.quora.com
3	https:/journals.elsevier.com/pattern-recognition

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

✓ CHALK & TALK	✓ STUD. ASSIGNMENT	☐ WEB RESOURCES
☑LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES

ASSESSMENT METHODOLOGIES-DIRECT [Append details of assessment methodologies actually employed (including design and analysis assessment) in spreadsheet format after the completion of each semester]

✓ ASSIGNMENTS	☐ STUD. SEMINARS	✓ TESTS/MODEL EXAMS	✓ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

✓ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	✓ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by (Course In-charge)
Approved by
Swapna Davies **HOD-ECE**

COURSE PLAN

UNIT	DETAILS	HOURS
I	**Introduction:** Basics of pattern recognition system, various applications, Machine Perception, classification of pattern recognition systems, Design of Pattern recognition system, Pattern recognition Life Cycle, Statistical Pattern Recognition: Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminant functions, Decision surfaces	9
II	Parameter estimation methods: Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation, Concept of feature extraction and dimensionality, Curse of dimensionality, Dimension reduction methods - Fisher discriminant analysis, Principal component analysis Hidden Markov Models (HMM) basic concepts, Gaussian mixture models.	**8**
III	Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification: Non-numeric data or nominal data, Decision trees: Concept of construction, splitting of nodes, choosing of attributes, overfitting, pruning	6
IV	Linear Discriminant based algorithm: Perceptron, Support Vector Machines	5
V	Multilayer perceptrons, Back Propagation algorithm, Artificial Neural networks, Classifier Ensembles: Bagging, Boosting / AdaBoost	6
VI	Unsupervised learning: Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation	5
	TOTAL HOURS	39

SAMPLE QUESTIONS

Module 1

1.Compare supervised, unsupervised and reinforcement learning techniques.
2.Draw the block diagram of a pattern recognition system.
3.Explain the terms i) features ii) training and iii) testing.
4. List various applications of pattern recognition systems and explain.
5. Explain loss function? How can it be factored into Bayes Decision theory.
6. For a two category Bayes classifier, the loss function is given by $\lambda 11=0.1$, $\lambda 21 =1$, $\lambda 12=1$, $\lambda 22 = 0.2$. The categories are equally likely. Obtain the decision rule.
7. Prove that a Bayes classifier is equivalent to a minimum distance classifier, assuming that the feature vector is Gaussian.

Module 2

8.Give details of expectation maximization algorithm.
9. Describe the significance of Gaussian mixture models in classifier design.
10 What is meant by the curse of dimensionality.
11. Define Fisher linear discriminant function. Derive the expression for its direction along which two classes are best separated

Module 3

13. With the help of an example, explain how a decision tree can be used for classification.
14.Explain the nonparametric methods for density estimation
15. What is pruning? Explain its significance.
16. Discuss the Parzen window method for density estimation.
17. Explain K Nearest Neighbour method for density estimation

Module 4

18.Why are SVM classifiers less prone to overfitting?
19.Explain the perceptron model for classification.
20.Define the various impurity measures used in test selection while constructing a decision tree.
21. Explain gradient descent algorithm and state perceptron convergence theorem.
22. Formulate SVM as an optimization problem. How support vector machines can be used for classification of data which are not linearly separable

Module 5

23.With a neat diagram explain the solution of XOR problem by a two layer perceptron.
24.Explain the structure of a multilayer feed forward network.
25.Write the basic gradient descent algorithm.
26.Write the activation functions used in back propagation networks.
27.Explain the classification capabilities of a two layer perceptron.
28.Explain the three layer perceptrons.
29.Explain the boosting approach in classifier ensembles.
30.Explain the bagging approach in classifier ensembles.

Module 6

31.Mention any five applications of clustering.
32.Write the major steps in divisive hierarchical clustering.
33.Differentiate between agglomerative and divisive clustering techniques
34.What is a dendogram? How is it useful for clustering.
35Define the problem of cluster validity.
36Write the steps in k means clustering algorithm.
37Write the major steps in agglomerative hierarchical clustering
38.Write the basic steps in clustering.

EC 465

MEMS

COURSE INFORMATION SHEET

PROGRAMME: Electronics & Communications Engineering	DEGREE: BTECH
COURSE: MEMS	SEMESTER: S4 CREDITS: 4
COURSE CODE: EC206 REGULATION: 2016	COURSE TYPE: ~~CORE~~/**ELECTIVE**
COURSE AREA/DOMAIN: ELECTRONICS	CONTACT HOURS: 3 hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY):	LAB COURSE NAME:

SYLLABUS:

UNIT	DETAILS	HOURS
MEMS and Microsystems applications, Review of Mechanical concepts, Actuation and Sensing techniques, Scaling laws in miniaturization, Materials for MEMS, Micro System fabrication techniques, Micro manufacturing, Micro system Packaging, Bonding techniques for MEMS, Overview of MEMS areas.		
I	MEMS and Microsystems: Applications – Multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys. Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	7
II	Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators	7
III	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.	5
IV	Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs, Silicon Piezo resistors Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography –Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching	9
V	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	9
VI	Bonding techniques for MEMS : Surface bonding, Anodic bonding, Silicon - on - Insulator, wire bonding, Sealing – Assembly of micro systems Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	5
	Total	42

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T	Chang Liu, Foundations of MEMS, Pearson 2012
T	Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002
R	Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000

R	Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
R	Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
R	Stephen D. Senturia, Microsystem design, Springer (India), 2006
R	Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
	NIL		

COURSE OBJECTIVES:

1	To understand the operation of major classes of MEMS devices/systems
2	To give the fundamentals of standard micro fabrication techniques and processes
3	To understand the unique demands, environments and applications of MEMS devices

COURSE OUTCOMES:

Sl No.	DESCRIPTION
1	Understand the working principles of micro sensors and actuators
2	Understand the application of scaling laws in the design of micro systems
3	Understand the typical materials used for fabrication of micro systems
4	Understand the principles of standard micro fabrication techniques
5	Appreciate the challenges in the design and fabrication of Micro systems

CO MAPPING WITH PO, PSO

CO No.	**Programme Outcomes (POs)**												**Programme-Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	**3**	**2**	**2**	**1**		**2**	**2**	**1**				**2**	**3**		**2**
2	**2**	**3**	**3**	**2**				**1**				**2**	**3**		**1**
3	**3**		**2**									**2**	**2**		
4			**3**		**1**	**1**						**2**	**3**	**1**	**1**
5		**2**		**2**	**1**	**1**						**2**	**3**	**1**	**1**
EC465	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**1**				**2**	**3**	**1**	**1**

JUSTIFICATION FOR CO-PO MAPPING

MAPPING	**LEVEL**	**JUSTIFICATION**
EC206.1-PO1	3	Working principles of micro sensors and actuators enhances engineering knowledge
EC206.1-PO2	2	Understanding working principles of micro sensors and actuators enables students to analyze a problem effectively
EC206.1-PO3	2	Understanding working principles of micro sensors and actuators enables students to design/develop solutions
EC206.1-PO4	1	Understanding working principles of micro sensors and actuators enables students to conduct investigations on complex problems
EC206.1-PO6	2	Understanding working principles of micro sensors and actuators enables students to generate engineering solutions to the society

EC206.1-PO7	2	Understanding working principles of micro sensors and actuators enables students to contribute for sustainable development
EC206.1-PO8	1	Understanding working principles of micro sensors and actuators enables students to practice engineering in an ethical way
EC206.1-PO12	2	Understanding working principles of micro sensors and actuators can contribute interest in students to MEMS and thus enhance life-long learning
EC206.2-PO1	2	Application of scaling laws enhances engineering knowledge
EC206.2-PO2	3	Scaling laws can be a tool for problem analysis
EC206.2-PO3	3	Scaling laws could contribute to design/development of solutions
EC206.2-PO4	2	Scaling laws could throw light to conduct investigations of complex problems
EC206.2-PO8	1	Scaling laws could hint an engineer whether he/she is approaching in an ethical way
EC206.2-PO12	2	As the technology is moving towards nano era, scaling laws motivates students for life-long learning
EC206.3-PO1	3	Awareness of typical materials used for fabrication enhances engineering knowledge
EC206.3-PO3	2	Awareness of typical materials used for fabrication could help in problem analysis
EC206.3-PO12	2	Awareness of typical materials used for fabrication could create a spark in students to know about the current/future trends in fabrication materials
EC206.4-PO3	3	Awareness about the principles of standard micro fabrication could lead to design/development of solutions
EC206.4-PO5	1	Awareness about the principles of standard micro fabrication could lead to the usage of Multiphysics tools like Comsol
EC206.4-PO6	1	Awareness about the principles of standard micro fabrication could lead to anlayse the societal need as an engineer
EC206.4-PO12	2	Awareness about the principles of standard micro fabrication could lead to further studies about recent trends
EC206.5-PO2	2	Knowledge about the challenges in the design and fabrication helps out in analyzing a problem
EC206.5-PO4	2	Knowledge about the challenges in the design and fabrication helps while conducting investigations of complex problems
EC206.5-PO5	1	Knowledge about challenges in the design and fabrication helps in selecting appropriate EDA tool
EC206.5-PO6	1	Appreciating the challenges in the design and fabrication awards responsibilities to an engineer
EC206.5-PO12	2	Appreciating the challenges in the design and fabrication attributes to life-long learning

JUSTIFICATION FOR CO-PSO MAPPING

MAPPING	LEVEL	JUSTIFICATION
EC206.1-PSO1	3	Knowledge on working principles of micro sensors and actuators enables students to design and implement MEMS devices and applications
EC206.1-PSO3	2	Knowledge on working principles of micro sensors and actuators add-ons to professional ethics, life-long learning & carry out responsibilities
EC206.2-PSO1	3	Knowledge of scaling laws enables students to design and implement MEMS devices

EC206.2-PSO3	1	Knowledge of scaling laws add-ons to professional ethics, life-long learning & carry out responsibilities
EC206.3-PSO1	2	Knowledge about typical materials used for fabrication helps the student to think about the possibility of design and implement his/her application
EC206.4-PSO1	3	Understanding principles of standard micro fabrication helps to design and implement MEMS devices
EC206.4-PSO2	1	Understanding principles of standard micro fabrication could attribute to usage of EDA tools
EC206.4-PSO3	1	Understanding principles of standard micro fabrication could attribute to professional ethics, life-long learning & carry out responsibilities
EC206.5-PSO1	3	Appreciating the challenges in the design and fabrication will create a venue to demonstrate the students skill in design and implementation
EC206.5-PSO2	1	Knowledge about the challenges in the design and fabrication helps in modeling MEMS devices using EDA tools
EC206.5-PSO3	1	Knowledge about the challenges in the design and fabrication attributes to professional ethics, life-long learning & carry out responsibilities

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	Understanding MEMS device applications in day-to-day activities	Class Seminars	1, 2, 3, 4, 5, 6

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURE/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

S No:	DESCRIPTION	PO MAPPING
1	. Identifying MEMS applications	1, 2, 3, 4, 5, 6

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Simple MEMS device design using open source software like SUGAR	1, 2, 3, 4, 5, 9, 10

WEB SOURCE REFERENCES:

1.	http://nptel.ac.in/courses/117105082/
2.	https://www.mepits.com/tutorial/255/vlsi/mems
3.	https://www.engr.sjsu.edu/trhsu/

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☐ WEB RESOURCES	

☑ LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☑ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☐ UNIV. EXAMINATION
☐STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by **Approved by**

Rony Antony P
Bonifus P L **Dr. Rithu James**
(Faculty in Charge) **(HoD)**

COURSE PLAN

I	MEMS and Microsystems: Applications – Multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys. Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	7
II	Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators	7
III	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.	5
IV	Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs, Silicon Piezo resistors Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography –Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching	9
V	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	9
VI	Bonding techniques for MEMS : Surface bonding, Anodic bonding, Silicon - on - Insulator, wire bonding, Sealing – Assembly of micro systems Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	5
	Total	42

SAMPLE QUESTIONS

Module I

1) Explain about the multidisciplinary nature of MEMS

2) Write notes with appropriate diagrams on the following mechanical structures in MEMS:

a. Beams

b. Cantilevers

c. Plates

d. Diaphragms

3) A cylindrical silicon rod is pulled on both ends with a force of 10 mN.The rod is 1 mm long and

100 □m in diameter. Find the stress and strain in the longitudinal direction of the rod.

4) The stiffness and the compliance matrix incorporate rich information about the Young's modulus

and the Poisson's ratio in three-dimensional space. Find the Young's modulus of silicon in [100]

direction based on the stiffness matrix.

5) Differentiate between stress and strain. What do you mean by shear stress and shear strain?

6) What is the significance of compliance matrix?

Module II

1) How do you determine spring constant of cantilever?

2) Discuss briefly about sensors and actuators with neat diagrams.

3) Explain the working principles of piezoelectric sensors and actuators.

4) Explain the working principle of magnetic actuators.

5) Write notes on longitudinal strain under pure bending.

6) Two cantilever beams of the same length and material, one with a cross section of 100 □m by 5□m

and a second one with 50 □m by 8□m. Which one is more resistant to flexural bending?

Module III

1) Differentiate between scaling in geometry and scaling in rigid body dynamics.

2) Explain the force scaling vector formulated by Trimmer and its significance.

3) What are the considerations to be done while scaling in electrostatic and electromagnetic forces?

4) Write notes on scaling about following:

a. Electricity and Fluid dynamics

b. Heat conduction and convection

Module IV

1) Explain about Micro System Fabrication with sufficient neat diagrams.

2) Explain the role of polymers in MEMS.

3) Discuss PDMS and PMMA with neat diagram

4) Compare and contrast between different materials used for MEMS.

5) Compare wet etching and dry etching.

Module V

1) Explain about LIGA process.

2) How bulk micro manufacturing is done?

3) What are the general considerations in microsystem packaging?

4) How surface micromachining is done?

5) Explain about microstereo lithography.

Module VI

1) Compare surface bonding and anodic bonding techniques available for MEMS.

2) Explain in detail Silicon-on-Insulator technique.

3) Discuss about wire bonding technique.

4) Write detailed notes with sufficient neat diagrams for the following MEMS areas:

a. RF MEMS

b. Bio MEMS

EC 463

SPEECH AND AUDIO PROCESSING

COURSE INFORMATION SHEET

PROGRAMME: U.G.	DEGREE: BTECH
COURSE: **SPEECH AND AUDIO PROCESSING**	SEMESTER: **Seven** CREDITS: 3
COURSE CODE: **EC 463** REGULATION: 2019	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: Signal Processing	CONTACT HOURS: 3 hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): **EC407**	LAB COURSE NAME: Signal processing Lab

SYLLABUS:

UNIT	DETAILS	HOURS
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method).	5
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC. Fundamentals of Speech recognition and Text-to-speech conversion	8
III	Speech coding, speech enhancement, Speaker Verification, Language Identification	7
IV	Channel coding:-Concepts of group and fields-Binary field arithmetic-Construction of Galois field-Vector spaces-Matrices Linear Block Codes:-Encoding-Decoding-Syndrome and error detection-Minimum distance of a block code-Error detection and correction-Capabilities of a linear block code-Standard array and syndrome decoding.	6
V	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods.	7
VI	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	6
TOTAL HOURS		60

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION

1	Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493.
2	Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547
3	Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
4	Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1st edition

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
EC 301	DIGITAL SIGNAL PROCESSING –		**5**

COURSE OBJECTIVES:

1	Familiarize the basic mechanism of speech production and learn the basic concepts of methods for speech analysis and parametric representation of speech
2	Get a overall picture about various applications of speech processing
3	Study of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and rendering
4	Study of Audio Compression Schemes

COURSE OUTCOMES:

SNO	DESCRIPTION	PO MAPPING
1	Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications	1,2,3,6,12
2	Ability to develop systems for various applications of speech processing	1,2,3,5,8,6,12
3	Learn Signal processing models of sound perception and application of perception models in audio signal processing	1,2,3,4,5,6,7,8,12
4	Acquire ability to implement audio compression algorithms and standards.	1,2,3,4,5,6,7,8,12

CO-PO-PSO MAPPING:

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	3	1			1						2	3	2	
2	3	3	2		2	1		2				1	3	2	2
3	3	3	3	3	2	2	1	1				2	2	2	3
4	3	3	3	3	2	2	1	1				2	3	2	3
ECE010705	**2.75**	**3**	**2.25**	**3**	**2**	**1.5**	**1**	**1.3**				**1.75**	**2.75**	**2**	**2.7**

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE ABOVE.

CO1	PO1	Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF).
	PO2	Signal Processing Models of Audio Perception:
	PO3	Basic anatomy of hearing System.
	PO6	Spatial Audio Perception and rendering: The physical and psychoacoustical basis of sound localization
	PO12	Parametric Coding of Multi-channel audio:
	PSO1	Speech production, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis,
	PSO2	Speech coding, Speech recognition, Speech enhancement, Text to speech conversion
CO2	PO1	Cepstral Analysis, MFCC
	PO2	Fundamentals of Speech recognition and Text-to-speech conversion
	PO3	Simultaneous Masking, Temporal Masking, Quantization Noise Shaping
	PO5	Redundancy removal and perceptual irrelevancy removal
	PO6	MOS score, MUSHRA score
	PO8	Parametric Coding of Multi-channel audio: Mid- Side Stereo,
	PO12	Parametric representation of speech: AR Model, ARMA model.
	PSO1	Signal Processing Models of Audio Perception,

	PSO2	Psycho-acoustic analysis,
	PSO3	Spatial Audio Perception and rendering,
CO3	PO1	Intensity Stereo, Binaural Cue Coding.
	PO2	speech enhancement, Speaker Verification, Language Identification
	PO3	LPC Analysis (LPC model, Auto correlation method).
	PO4	Fundamentals of Speech recognition and Text-to-speech conversion
	PO5	Auditory Filter Banks,
	PO6	Pre-echo and pre-echo suppression, psycho-acoustic modelling
	PO7	Parametric representation of speech: AR
	PO12	Mid- Side Stereo, Intensity Stereo,
	PSO1	Signal Processing Models of Audio Perception
	PSO2	Psycho-acoustic analysis,
	PSO3	Spatial Audio Perception and rendering,
CO4	PO1	Basic concept of compression
	PO2	Mathematical tools for compression
	PO3	Application oriented compression techniques for speech signals
	PO4	Sampling rate and bandwidth requirement for digital audio,
	PO5	Redundancy removal and perceptual irrelevancy removal,
	PO6	psycho-acoustic modelling, adaptive quantization and bit allocation methods
	PO7	Loss less coding methods.
	PO12	MPEG2-AAC coding standard, MDCT and its properties
	PSO1	Audio compression methods, Parametric Coding
	PSO2	Multi-channel audio, Transform coding

	PSO3	digital audio, audio quality analysis.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	Emotional recognition Techniques	ASSIGNMENT	1,2,3,6,12

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Hypothetical analysis of speech signals, HMM models	1,2,3,6,12

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Mathematical Analysis of various coding schemes	1,2,3

WEB SOURCE REFERENCES:

1	http://homes.esat.kuleuven.be/~dspuser/dasp/material.html
2	http://pfister.ee.duke.edu/courses/ece485/
3	https://www.ece.ucsb.edu/Faculty/Rabiner/ece259/speech%20course.html

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

■ CHALK & TALK	■ STUD. ASSIGNMENT	■ WEB RESOURCES	
. LCD/SMART BOARDS	□ STUD. SEMINARS	□ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT [Append details of assessment methodologies actually employed (including design and analysis assessment) in spreadsheet format after the completion of each semester

■ ASSIGNMENTS	□ STUD. SEMINARS	■ TESTS/MODEL EXAMS	■ UNIV. EXAMINATION
□ STUD. LAB PRACTICES	□ STUD. VIVA	□ MINI/MAJOR PROJECTS	□ CERTIFICATIONS
□ ADD-ON COURSES	□ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

■ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	■ STUDENT FEEDBACK ON FACULTY (TWICE)
□ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	□ OTHERS

Prepared by
Naveen N

Approved by
HOD

COURSE PLAN

UNIT	DETAILS	HOURS
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method).	5
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC. Fundamentals of Speech recognition and Text-to-speech conversion	8
III	Speech coding, speech enhancement, Speaker Verification, Language Identification	7
IV	Channel coding:-Concepts of group and fields-Binary field arithmetic-Construction of Galois field-Vector spaces-Matrices Linear Block Codes:-Encoding-Decoding-Syndrome and error detection-Minimum distance of a block code-Error detection and correction-Capabilities of a linear block code-Standard array and syndrome decoding.	6
V	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods.	7
VI	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	6
TOTAL HOURS		60

SAMPLE QUESTIONS

MODULE 1

1. Draw the source filter model for speech production.
2. What are formants? What is its significance in speech modelling?
3. Explain any one method for continuous speech recognition.
4. Give an example each for the following speech sounds
   a) fricatives b)stops c) nasals d) semi-vowels e) vowels
5. Draw & explain the source filter model for speech production.
6. What are formants? What is its significance in speech modeling?
7. Differentiate between voiced & unvoiced speech signals.
8. Define short – time energy of a signal. How is it computed?
9. Explain the concept of linear prediction in the analysis of speech.
10. Write the algorithm for computing LPC coefficients using autocorrelation method.
11. Define briefly the idea behind short time energy and short time zero crossing rate.
12. Explain with the help of a neat diagram the acoustic theory of speech production
13. Define mathematically the need of STFT & Spectrogram in speech signals.
14. Define with proper mathematical equations the time domain analysis of speech signal
15. Briefly define with the help of neat diagram the acoustic theory of speech production.

MODULE 2

1. Explain the concept of Linear prediction in the analysis of speech
2. Explain the concept of homomorphic signal processing with the help of necessary block diagrams.
3. Explain any one method for speech enhancement.
4. Explain with the help of a block diagram the steps involved in obtaining MFCC coefficients of a speech signal.
5. Define the fundamentals of Speech recognition.
6. With the help of a block diagram, Explain the steps involved in computing MFCC

of a speech signal.

7. Explain the principle of Text – to – speech synthesis system with the help of suitable block diagram.
8. Define with proper mathematical equations the frequency domain analysis of speech signal.
9. Define any two parametric representations of speech signal.

MODULE 3

1. Define absolute threshold of hearing. What is its significance in audio perception.
2. With a block diagram explain ADPCM technique of coding speech.
3. List various steps involved in language identification
4. Explain any one method for speech enhancement.
5. Explain the steps involved in speaker verification.
6. Explain with the help of a neat diagram, the basic anatomy of hearing system.
7. Explain MPEG psychoacoustic model of audio perception.
8. With a block diagram, explain ADPCM technique of coding speech.
9. Suppose the alphabet is [A, B, C, D, E, F, $], in which $ is a special symbol used to terminate the message, encode the sequence CADEC$ using arithmetic coding technique. The known probability distribution given is P(A) = 0.2, P(B) = 0.1, P(C) = 0.2, P(D) = 0.05, P(E) = 0.3, P(F) = 0.05, P($) = 0.1 respectively.
10. Encode the given sequence using LZ78 algorithm "abbarbarraybbybbarrayarbbaya".
11. Explain the significance of sub-banding coding for speech signals.
12. List various steps involved in language identification.
13. Define the steps of speaker verification in a speech signal.
14. Explain implicit and explicit language identification system with block diagram.
15. Define speaker verification system in detail and state its difference with speaker identification.

MODULE 4

1. Explain MPEG psychoacoustic model of audio perception.
2. What are the different types of frequency masking?
3. Explain MPEG psychoacoustic model of audio perception.

4. Explain the psycho-acoustic analysis steps of an audio signal.
5. With the help of a neat diagram, explain the anatomy of hearing System.
6. Explain mathematically the concept of MDCT and its properties.
7. Briefly define the audio compression methods.
8. Explain any two subjective analysis methods to measure the audio quality.
9. Explain the basic anatomy of the hearing system, with the help of a neat diagram.

MODULE 5

1. Define the terms (i) Interaural Time Difference (ii) Interaural Intensity Difference
2. Describe the principles of spatial audio coding and rendering
3. Describe the pre echo effect in AAC coders and a method to control this effect.
4. Explain the duplex theory of sound localization.
5. Explain any one lossless audio coding technique.
6. Explain any two spatial audio standards.
7. Explain any one objective analysis method to analyse the audio quality.
8. Explain the idea behind redundancy removal and perceptual irrelevancy removal in audio compression.

MODULE 6

1. Determine the sampling rate and bandwidth required for CD quality digital audio.
2. Describe the Modified Discrete Cosine Transform used in MPEG AAC.
3. Describe the Modified Discrete Cosine Transform used in MPEG AAC.
4. Explain any one objective analysis method to analyse the audio quality.
5. Briefly define the MPEG2-AAC coding standard of digital audio.
6. Briefly define the idea behind the audio compression methods.
7. Briefly define the MPEG2-AAC coding standard of digital audio.
8. Explain any one objective analysis method to analyse the audio quality.
9. Define the fundamentals of spatial audio perception and rendering of audio signals.

EC 451

SEMINAR & PROJECT PRELIMINARY

COURSE INFORMATION SHEET

PROGRAMME: UG PROGRAMME IN ELECTRONICS & COMMUNICATION ENGINEERING	DEGREE: B. TECH.
COURSE: Seminar and Project Preliminary	SEMESTER: VII CREDITS: 2
COURSE CODE: EC 451 REGULATION: 2015	COURSE TYPE: LAB
COURSE AREA/DOMAIN: ELECTRONICS & COMMUNICATION	CONTACT HOURS: 5 Practical Hours/Week
CORRESPONDING LAB COURSE CODE (IF ANY): NIL	LAB COURSE NAME: NIL

SYLLABUS:

UNIT	DETAILS	HOURS
I	**Seminar**: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.	
II	**Project preliminary**: Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board. The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report	

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	IEEE Conferences and Journals

COURSE PRE-REQUISITES:

COURSE CODE	COURSE NAME	DESCRIPTION	SEM
	Should have completed 7 semesters of the B. Tech. programme.		

COURSE OBJECTIVES:

Sl. No.	DESCRIPTION
1	To develop skills in doing literature survey, technical presentation and report preparation.

2	To enable project identification and execution of preliminary works on final semester/ project

COURSE OUTCOMES:

Sl.No.	DESCRIPTION	PO MAPPING
1	Analyze a current topic of professional interest and present it before an audience	1,2,4,7,PSO1,PSO2
2	Identify an engineering problem, analyze it and propose a work plan to solve it.	1,2,4,PSO1,PSO2
3	Student develops the capability to work in a team to design and implement a solution to the problem with the help of appropriate tools	1,2,3,4,5,6,7,8,9,10,11,12,PSO1,PSO2,PSO3
4	Student develops the skills required to present and defend his/her work	9,10,11
5	Student understands the role of time management in the implementation of the project	9,11,PSO1,PSO3

CO MAPPING WITH PO, PSO															
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	3		3			1						3	2	
CO 2	1	3		2									1	2	
CO 3	2	3	3	2	3	2	2	2	3	1	1	2	3	3	2
CO 4									1	3	2				
CO 5									2		3		1		1
EC451	1.6	3	3	2.33	3	2	1.5	2	2	2	2	2	2	2.33	1.5

JUSTIFICATION FOR CO-PO

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	NIL		

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Students learn to make reports in LaTeX	10,11
2	Students do self-learning of MATLAB, PIC programming, HDL simulation and other tools as required by their project.	1,2,5,11,PSO1, PSO2

Mapping	**Level**	**Justification**
CO1-PO1	2	For analyzing complex engineering problems deep knowledge in basic science and engineering is required
CO1-PO2	3	Students gains the ability to identify, formulate and analyze engineering problems
CO1-PO4	3	research approach to their project by conducting literature survey and problem investigation
CO1-PO7	1	Indentification and findingsolutions for societal and environmental problems is part of problem analysis
CO2-PO1	1	Knowledge in basic science and engineering fundamentals is obtained by conducting literature survey
CO2-PO2	3	Literature survey provides information and approach method for problem analysis
CO2-PO4	2	Research approach to a problem obtained from various literatures is used to conduct investigation on complex problems
CO3-PO1	2	Application of Knowledge in basic science and engineering fundamentals is required in project design and development
CO3-PO2	3	Appropriate tools knowledge can be used for effective problem analysis
CO3-PO3	3	Appropriate tools knowledge can help in design and development of solutions to engineering problems
CO3-PO4	2	Appropriate tools knowledge can be used for deep investigation of complex problems
CO3-PO5	3	Various software tools is necessary for project analysis and implementation

CO3-PO6	2	Deep knowledge in software tools can be utilized to develop solutions in health, safety etc
CO3-PO7	2	Student projects serve as an solution for societal and environmental problems .
CO3-PO8	2	Developing a solution/product provides a platform to apply ethical principles
CO3-PO9	3	Project work provides a platform for students to perform effectively as a team member or lead
CO3-PO10	1	Project work provides the students an opportunity for effective presentation and documentation on develop phases of project
CO3-PO11	1	Perform as a team and contribute as an individual
CO3-PO12	2	The knowledge gained in doing main project work will help the students in project management in various industries
CO4-PO9	1	Present and defend thesis as team
CO4-PO10	3	Project work provides the students an opportunity for effective presentation and documentation
CO4-PO11	2	Present and defend thesis as team as a part of project management
CO5-PO9	2	Efficient project management by working as a team
CO5-PO11	3	Efficient time management leads to efficient project management
CO1-PSO1	3	Project work provides a platform to demonstrate their technical skills
CO1-PSO2	2	Project work provides a platform to demonstrate their practical skills in various EDA tools.
CO2-PSO1	1	Literature survey provides the appropriate methods to demonstrate their technical skills.
CO2-PSO2	2	Studies conducted on various tools for their project

3	Enhancement of the projects for specific applications	1,3,6

CO3-PSO1	3	Knowledge in various tools and working as a team enables the students to demonstrate their skills in engineering fields.
CO3-PSO2	3	Appropriate tools knowledge can help in analysis ,design and development of solutions to engineering problems
CO3-PSO3	2	Working in a team provides the students,to demonstrate a sense of professional ethics and their responsibilities.
CO5-PSO1	1	Develop project /applications with help of efficient project planning.
CO5-PSO3	1	Sense of professional ethics practiced as a result of proper project management

DESIGN AND ANALYSIS TOPICS:

Sl. No.	DESCRIPTION	PO MAPPING
1	Signal processing	1,2,3,4,5,PSO1,PSO2
2	Communication systems	1,2,3,4,5,PSO1,PSO2
3	VLSI and embedded systems	1,2,3,4,5,PSO1,PSO2

WEB SOURCE REFERENCES:

Sl. No.	DESCRIPTION
1	IEEE Journals and Conference papers

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

■ CHALK & TALK	☐ STUD. ASSIGNMENT	■ WEB RESOURCES	
☐ LCD/SMART BOARDS	■ STUD. SEMINARS	☐ ADD-ON COURSES	

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ASSESSMENT METHODOLOGIES-INDIRECT

■ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	■ STUDENT FEEDBACK ON FACULTY
■ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by
Anoop Thomas
Bonifus P L
Preethi Bhaskaran
(Course In-charges)

Approved by

HOD-ECE

COURSE PLAN

UNIT	DETAILS
I	**Seminar**: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.
II	**Project preliminary**: Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board. The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

EC 431

COMMUNICATION SYSTSEM LAB

(OPTICALV &MICROWAVE)

COURSE INFORMATION SHEET

PROGRAMME: Electronics & Communication Engineering	DEGREE: BTECH
COURSE: Communication Systems Lab	SEMESTER: 7 CREDITS: 1
COURSE CODE: EC431 REGULATION:2015	COURSE TYPE: CORE
COURSE AREA/DOMAIN: Advanced Communication[Optical & Microwave]	CONTACT HOURS: 3 hours
CORRESPONDING THEORY COURSE CODE (IF ANY):EC 403,EC 405	COURSE NAME: Microwave & Radar Engineering, Optical Communication

SYLLABUS:

UNIT	DETAILS	HOURS
I	**Microwave Experiments:** [Six mandatory] 1. GUNN diode characteristics. 2. Reflex Klystron Mode Characteristics. 3. VSWR and Frequency measurement. 4. Verify the relation between Guide wavelength, free space wave length and cut off wave length for rectangular wave guide. 5. Measurement of E-plane and H-plane characteristics. 6. Directional Coupler Characteristics. 7. Unknown load impedance measurement using smith chart and verification using transmission line equation. 8. Antenna pattern measurement.	18 Hrs
II	**Optical Experiments:** [Six mandatory] 1. Measurement of Numerical Aperture of a fiber, after preparing the fiber ends. 2. Study of losses in optical fiber. 3. Setting up of Fiber optic Digital link. 4. Preparation of a Splice joint and measurement of the splice loss. 5. Power Vs Current [P-I] characteristics and measure slope efficiency of Laser Diode. 6. Voltage Vs Current [V-I] characteristics of Laser diode. 7. Power Vs Current [P-I] characteristics and measure slope efficiency of LED. 8. Voltage Vs Current [V-I] characteristics of LED. 9. Characteristics of Photodiode and measure the responsivity. 10. Characteristics of Avalanche Photo Diode and measure responsivity.	18 Hrs
	TOTAL HOURS	36 Hrs

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	Liao S.Y."Microwave devices and Circuits", Prentice Hall Of India, New Delhi, 3rd Ed. 2006
2	Annapurna Das and Sisir Das, "Microwave Engineering", Tata-McGraw Hill , New Delhi, 2008.Tata Mc Graw Hill
3	John M Senior, "Optical fiber Communications Principles and Practice:",Pearson Education
3	Djafer K Mynbaev, "Fibre optic communication technology:", Pearson Education.
4	Kulkarni M, Microwave and Radar Engineering, 4/e, Umesh Publications, 2012.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
EC30	ANTENNA AND WAVE PROPAGATION	Antenna Radiation Pattern	6

EC403	MICROWAVE ENGINEERING	Microwave equipments	7
EC405	OPTICAL COMMUNICATION	Optical equipments	7

COURSE OBJECTIVES:

1	Understand the design ,testing and analysis of few microwave devices and circuits
2	Learn how to conduct experiment on the measurement of various microwave parameters VSWR, frequency and wavelength etc.
3	Understand the basics of Antenna Measurements and Radiation Pattern
4	Implement the characteristics of various optical diodes.
5	Understand the basics of Optical Communication.

COURSE OUTCOMES:

Sl.No.	DESCRIPTION
1	Students will be able to design the MW bench setup to study the characteristics of various MW active and passive devices
2	Students will be able to measure various MW parameters such as VSWR, frequency, impedance and wavelength.
3	Students will be able to measure the numerical aperture and various losses in optical fiber.
4	Students will understand the basics of Antenna Measurements.
5	Students will understand the basic characteristics of optical diodes.

CO mapping with PO, PSO

	PO1	PO2	PO3	PO 4	PO5	PO6	PO9	PO 12	PSO1	PSO2	PSO3
CO 1	2	2	3	2	2	3	2		2	2	
CO 2	3	2	2		1	2	2		2		
CO 3	3	2	2		1	1	2		3		
CO 4	2	2	2	1		1	1		3		
CO 5	3	3	3	1	2	1	2		3	3	2
EC 431	2.6	2.2	2.4	1.33	1.5	1.6	1.8		2.6	2.5	2
	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO 12	PSO1	PSO2	PSO3

CO 1	MW devices like klystron,GUNN diode, Directional coupler, TEE junctionsetc requires adequate knowledge in basic science	Analysis of reflex kystron oscillator and other devices are required to conduct experiment	The solutions for MW Communication system requires better understanding of bench set up and component design.	Research based knowledge is used for the analysis of MW devices	MW Engineering needs more research for effective design of MW link.	Design of MW systems requires advanced tools which can deal with GHz freq.	Individual and team work is required Conduct MW experiments		MW system requires devices which can handle GHz freq range RF signal	MW systems needs the usage of tools like Simulink etc	
CO 2	Measurement of MW Parameters such as VSWR,freq ,impedance and wavelength.	identify the types of various bench set up for measuring MW parameters frequency,impedance,power etc,.	Appropriate tools knowledge can be used for deep investigation of complex problems		Students gains the ability to identify, formulate and analyze engineering problem	Design of efficient system require advanced tools which can deal with MW systems	Students can work in team or individual to function effectively		provide a platform to demonstrate their practical skills		

CO 3	Students get the ability to understand optical fiber	Students understand the mechanism to implement the fiber loss expt	Appropriate tools knowledge can be used for deep investigation of complex problems		Students gains the ability to identify, formulate and analyze engineering problem	Design of efficient system require advanced tools which can deal with optical systems	Students can work in team or individual .		provide a platform to demonstrate their programming skills	
CO 4	Antenna design needs deep knowledge in basic science disciplines	Antenna design needs deep knowledge in mathematics and basic science disciplines	Equipments used for communication applications needs to be compatible with existing systems						Antenna selection plays a vital role in satellite system development.	

CO 5	Basic characteristics of optical diodes	identify the types of various bench set up for measuring MW parameters frequency,impedance,power etc,.	Introduction of optical diodes	Analysis of various measurement techniques			Design and implementation of opical commn system	Conduct experiment such as various diode characteristics	Implementation of social relevant projects using the basics of optical diodes

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS
1	Antenna measurement and Radiation Pattern	Included

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SNO	DESCRIPTION
1	Simulation of Microwave components

WEB SOURCE REFERENCES:

1	www.matworks.com
2	www.nptel.iit.a.c.in
2	www.slideshare.net

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☑ WEB RESOURCES	
☐ LCD/SMART BOARDS	☐ STUD. SEMINARS	☑ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
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ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by

Rinju Mariam Rolly
Deepthy G S
Aarathi Sankar

Approved by

(HOD)

COURSE PLAN

UNIT	DETAILS	HOURS
I	**Microwave Experiments:** [Six mandatory] 1. GUNN diode characteristics. 2. Reflex Klystron Mode Characteristics. 3. VSWR and Frequency measurement. 4. Verify the relation between Guide wavelength, free space wave length and cut off wave length for rectangular wave guide. 5. Measurement of E-plane and H-plane characteristics. 6. Directional Coupler Characteristics. 7. Unknown load impedance measurement using smith chart and verification using transmission line equation. 8. Antenna pattern measurement.	18 Hrs
II	**Optical Experiments:** [Six mandatory] 1. Measurement of Numerical Aperture of a fiber, after preparing the fiber ends. 2. Study of losses in optical fiber. 3. Setting up of Fiber optic Digital link. 4. Preparation of a Splice joint and measurement of the splice loss. 5. Power Vs Current [P-I] characteristics and measure slope efficiency of Laser Diode. 6. Voltage Vs Current [V-I] characteristics of Laser diode. 7. Power Vs Current [P-I] characteristics and measure slope efficiency of LED. 8. Voltage Vs Current [V-I] characteristics of LED. 9. Characteristics of Photodiode and measure the responsivity. 10. Characteristics of Avalanche Photo Diode and measure responsivity.	18 Hrs
	TOTAL HOURS	36 Hrs