COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC401	INFORMATION THEORY & CODING	4-0-0-4	2015

Prerequisite:
MA204 Probability, Random Processes and Numerical Methods,EC302 Digital Communication

Course objectives:

1. To understand the concept of information
2. To understand the limits of error free representation of information signals and the transmission of such signals over a noisy channel
3. To design and analyze data compression techniques with varying efficiencies a per requirements
4. To understand the concept of various theorems proposed by Shannon for efficient data compression and reliable transmission
5. To have idea on the different coding techniques for reliable data transmission
6. To design an optimum decoder for various coding schemes used.

Syllabus: Concept of amount of information, Entropy, Source coding, Channel Capacity, Shannon's Limit, Rate Distortion Theory, Channel Coding, Linear Block Codes, Cyclic codes, Cryptography, Convolutional Codes, Viterbi Algorithm

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

1. Apply the knowledge of Shannon's source coding theorem and Channel coding theorem for designing an efficient and error free communication link.
2. Analyze various coding schemes
3. Design an optimum decoder for various coding schemes used.

Text Books:

1. Symon Haykins: Digital Communication Systems , Wiley India, 2013.
2. P.S.Sathya Narayana: Concepts of Information Theory & Coding , Dynaram Publications,2005

References:

1. Bose, Information theory coding and cryptography, 3e McGraw Hill Education India , 2016
2. J S Chitode, Information Theory and Coding, Technical Publications, Pune, 2009
3. Kelbert & Suhov, Information theory and coding by examples, Cambridge University Press, 2013
4. Shu Lin & Daniel J. Costello.Jr., Error Control Coding : Fundamentals and Applications, 2/e,Prentice Hall Inc.,Englewood Cliffs, NJ,2004
5. D.E.R. Denning, Cryptography and Data Security, Addison Wesley, 1983.
6. David J.C Mackay, Information Theory, Inference and Learning Algorithms, Cambridge,2005.
7. Paul Garrett, The mathematics of Coding Theory, Prentice Hall, 2004.
8. Das Mullick Chatterjee, Principles of Digital communication , Wiley Eastern Ltd, 1986

Course Plan

Module	Course content (54 hrs)	Hours	Sem. Exam Marks
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	**15**

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	
FIRST INTERNAL EXAM			
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	**15**
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	**15**
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	**20**
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	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC403	MICROWAVE & RADAR ENGINEERING	3-0-0-3	2015

Prerequisite:
EC303 Applied Electromagnetic Theory, EC306 Antenna & Wave Propagation

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.

Syllabus:
Microwaves: introduction, advantages, Cavity Resonators, Microwave vacuum type amplifiers and sources, Klystron Amplifiers, Reflex Klystron Oscillators, Magnetron oscillators, Travelling Wave Tube, Microwave measurements, Microwave hybrid circuits, Directional couplers, Solid state microwave devices, Gunn diodes, Radar, MTI Radar, Radar Transmitters, Radar receivers.

Expected outcome:
At the end of the course, students will be able to understand the basics of microwave engineering and radar systems.

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 Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks
I	**Microwaves:** introduction, advantages, Cavity Resonators - Rectangular and Circular wave guide resonators- Derivation of resonance frequency of Rectangular cavity.	4	15
	Microwave vacuum type amplifiers and sources: Klystron Amplifiers - Re-entrant cavities, Velocity modulation, Bunching (including analysis), Output power and beam loading.	4	
II	**Reflex Klystron Oscillators**: Derivation of Power output, efficiency and admittance	2	

	Magnetron oscillators - Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.	3	
FIRST INTERNAL EXAM			
III	**Travelling Wave Tube** - Slow wave structures, Helix TWT, Amplification process, Derivation of convection current, axial electric field, wave modes and gain.	4	**15**
	Microwave measurements – Measurement of impedance, frequency and power	2	
IV	**Microwave hybrid circuits** – Scattering parameters, Waveguide tees-Magic tees, Hybrid rings, Corners, Bends, and Twists. Formulation of S-matrix.	5	**15**
	Directional couplers:Two hole directional couplers, S-matrix of a directional coupler. Circulators and isolators.	4	
V	**Solid state microwave devices** – Microwave bipolar transistors, Physical structures, Power frequency limitations equivalent circuit. Principle of **Tunnel diodes** and tunnel diode oscillators.	4	**20**
	Gunn diodes – Different modes, Principle of operation Gunn Diode Oscillators.	2	
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	5	**20**
	Radar Transmitters. Radar Modulator-Block diagram, **Radar receivers**- noise figure, low noise front ends, Mixers, Radar	3	
END SEMESTER EXAM			

Note:- Analysis is not required in this course

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 60 % for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC405	OPTICAL COMMUNICATION	3-0-0-3	2015

Prerequisite:
EC203 Solid State Devices. EC205 Electronic Circuits

Course objectives:

1. To understand the concept of light transmission through optical fibers.
2. To understand the concept of optical sources and detectors.
3. To understand the performance comparison of various optical transmission schemes.
4. To understand the working of optical components.
5. To understand the principle of operation of optical amplifiers.
6. To understand WDM technique.

Syllabus: Generallight wave system, advantages ,classification of light wave systems, fibre types , linear and non linear effects in fibres,Fibre materials, fabrication of fibres, Optical sources, LEDs and LDs Optical detectors, Optical receivers, Digital transmission systems, Optical Amplifiers, WDM concept, Introduction to free space optics, Optical Time Domain Reflectometer (OTDR).

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

1. Know the working of optical source and detectors.
2. Compare the performance of various optical modulation schemes.
3. Apply the knowledge of optical amplifiers in the design of optical link.
4. Analyse the performance of optical amplifiers.
5. Know the concept of WDM
6. Describe the principle of FSO and LiFi.

Text Books:

1. Gerd Keiser: Optical Fiber Communications,**5/e**,McGraw Hill, 2013.
2. Mishra and Ugale,Fiberoptic Communication, Wiley ,2013.

References:

1. Joseph C. Palais – Fiber Optic Communications, 5/e Pearson, 2013.
2. John M Senior- Optical communications, **3/e**, Pearson, 2009.
3. Hebbar,Optical fiber communication, Elsavier,2014
4. Chakrabarthi,Optical Fiber Communicatio, McGraw Hill, 2015.
5. Mynbaev ,Scheiner, Fiberoptic Communication Technology,Pearson, 2001.
6. Bandyopadhay , Optical communicatoion and networks.PHI, 2014.
7. Khare, Fiber optics and optoelectronics, Oxford university press, 2013.
8. Subir kumar sarkar, Optical fibers and fiberoptic communication system,S Chand, 2012.
9. Keiser - Optical Communication Essentials (SIE), 1e McGraw Hill EducationNew Delhi, 2008
10. Arumugam, Optical communication and sensors,Anuradha publications, 2009.
11. T. L. Singal, Optical Fiber Communications Principles and Applications, Cambridge University Press, 2001

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks

I	Generallight 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 Mode Dispersion, attenuation- absorption, bending and scattering losses.	8	**15**
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	
FIRST INTERNAL EXAM			
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	**15**
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	**15**
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	**20**
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	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 407	COMPUTER COMMUNICATION	3-0-0-3	2015

Prerequisite:NIL

Course objectives:

1. To understand the basic concepts of computer network and how data communication occurs through a computer network.
2. To introduce students to the fundamental techniques used in implementing secure network communications, and give them an understanding of common threats and attacks.

Syllabus: Introduction to computer communication, Transmission modes, Networks, Interconnection of Networks: Internetwork, Network models:OSI model, TCP/IP protocol suite. Switching, Physical Layer, Data Link Layer, Media access control, Ethernet(802.3), Logical link control, Wireless LAN(802.11), Virtual LAN, Networking devices, Logical addressing: IPV4, IPV6, Address mapping, Subnetting, CIDR, ICMP, IGMP, DHCP, Routing, Transport Layer, Congestion Control & Quality of Service, Application Layer, Introduction to system and network security, security attacks, security services and mechanisms. Network Security, System Security, Firewalls, Intrusion detection, IDS, Malicious software and Internet Security, Viruses and related threats, virus countermeasures, denial of service attacks, Hacking.

Expected outcome:

On completion of this course, the students will have a thorough understanding of:

- Different types of network topologies and protocols.
- The layers of the OSI model and TCP/IP with their functions
- The concept of subnetting and routing mechanisms.
- The basic protocols of computer networks, and how they can be used to assist in network design and implementation.
- Security aspects in designing a secure computer communication system.

Text Books:

1. Data Communications and Networking, 4/e, Behrouz A Forouzan, Tata McGraw-Hill, 2006.
2. Cryptography & Network Security , Behrouz A. Forouzan, IV Edition,Tata McGraw-Hill, 2008

References:

1. Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011.
2. J F Kurose, Computer Network A Topdown Approach Featuring the Internet,3/e,Pearson Education, 2010
3. S.Keshav: An Engineering Approach to Computer Networking, Pearson Education, 2005.
4. Achyut S.Godbole Data Communication and Networking,2e, McGraw –Hill Education New Delhi,2011

Course Plan

Module	Course content (42 hrs)	Hours	Sem. Exam Marks

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	2	15
	Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks: Internetwork	2	
	Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.	2	
II	Physical Layer: Guided and unguided transmission media (Co-axial cable, UTP,STP, Fiber optic cable)	2	15
	Data Link Layer: Framing, Flow control(stop and wait , sliding window flow control)	2	
	Error control, Error detection(check sum, CRC), Bit stuffing, HDLC	2	
	Media access control: Ethernet(802.3), CSMA/CD, Logical link control, Wireless LAN(802.11), CSMA/CA	2	
FIRST INTERNAL EXAM			
III	Network Layer Logical addressing : IPv4 & IPV6,	2	15
	Address Resolution protocols (ARP, RARP)	2	
	Subnetting, Classless Routing(CIDR), ICMP,IGMP,DHCP	3	
	Virtual LAN, Networking devices (Hubs, Bridges & Switches)	1	
IV	Routing: Routing and Forwarding, Static routing and Dynamic routing	1	15
	Routing Algorithms: Distance vector routing algorithm, Link state routing(Dijkstra's algorithm)	2	
	Routing Protocols: Routing Information protocol(RIP), Open Shortest Path First(OSPF), Border Gateway Protocol(BGP), MPLS	3	
SECOND INTERNAL EXAM			
V	Transport Layer –UDP, TCP	1	20
	Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control (Open Loop, Closed Loop & Congestion control in TCP), QoS and Flow Characteristics	4	
	Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP,POP3,MIME, SNMP	3	
VI	Introduction to information system security, common attacks	1	20
	Security at Application Layer (E-MAIL, PGP and S/MIME). Security at Transport Layer (SSL and TLS). Security at Network Layer (IPSec).	3	

	Defense and counter measures: Firewalls and their types. DMZ, Limitations of firewalls, Intrusion Detection Systems - Host based, Network based, and Hybrid IDSs	2	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 90 % for theory and 10% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC409	CONTROL SYSTEMS	3-0-0-3	2015

Prerequisite:
MA 101 Calculus, MA102 Differential Equations, MA201 Linear Algebra & Complex Analysis, MA204 Probability, Random Processes and Numerical Methods,EC202 Signals & Systems

Course objectives:

- To introduce the elements of control system and their modeling the system
- To introduce methods for analyzing the time response, the frequency response and the stability of systems.
- To design control systems with compensating techniques.
- To introduce the state variable analysis method.
- To introduce basic concepts of digital control systems.

Syllabus: Control system , types and application, feedback system, mathematically modelling of control systems, block diagram representation, signal flow graph, Mason's formula, test signals, time response analysis, frequency analysis, stability concepts and analysis, state variable analysis, Observability and controllability, digital control systems , state space analysis, Jury's test

Expected outcome:
Students should be able to

- Represent mathematically a systems and deriving their transfer function model.
- Analyse the time response and frequency response of the systems for any input
- Find the stability of system
- Design a control system with suitable compensation techniques
- Analyse a digital control system.

Text Books

1. Farid Golnaraghi,Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
2. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education.
3. Gopal - Control Systems, 4e, McGraw Hill Education India Education , 2012.

References

1. Norman S Nise ,Control System Engineering,5/e, Wiley India
2. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002.
3. Richard C Dorf and Robert H Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.
4. Gopal - Digital Control and State Variable Method, 4e, McGraw Hill Education India 2012.

Course Plan

Module	Course content (42 hrs)	Hours	Marks
I	Basic Components of a Control System, Applications , Open-Loop Control Systems and Closed-Loop Control Systems	1	15
	Effects of Feedback on Overall Gain, Stability, External, Disturbance or Noise ,	1	

	Types of Feedback Control Systems, Linear versus Nonlinear Control Systems ,Time-Invariant versus Time-Varying Systems .	1	
	Overview of solving differential equations using Laplace transforms	1	
	Mathematical modeling of control systems - Mechanical and electromechanical systems.	2	
	Block diagram representation and reduction methods	2	
	Signal flow graph and Mason‘s rule formula.	2	
II	Standard test signals. Time response specifications.	1	15
	Time response of first and second order systems to unit step input,ramp inputs. time domain specifications	2	
	Steady state error and static error coefficients.	1	
	Dynamic error coefficient and its evaluation.	1	
FIRST INTERNAL EXAM			
III	Stability of linear control systems: methods of determining stability, Routh‘s Hurwitz Criterion.	2	15
	Root Locus Technique: Introduction, properties and its construction.	2	
	Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	1	
IV	Nyquist stability criterion: fundamentals and analysis	2	15
	Relative stability: gain margin and phase margin. Stability analysis with Bode plot.	2	
	Design of Control Systems: PD and PI controllers	2	
	Design with phase-lead and phase-lag controllers (frequency domain approach).	2	
SECOND INTERNAL EXAM			
V	State variable analysis: state transition matrix and equation,State space representation of Continuous Time systems	2	20
	Transfer function from State Variable Representation, Solutions of the state equations	2	
	Concepts of Controllability and Observability Kalman Test	2	
VI	Discrete Control systems fundamentals: Overview of Z transforms. State space representation for Discrete time systems.	2	20
	Sampled Data control systems ,Sampling Theorem, Sample & Hold, Open loop & Closed loop sampled data systems.	2	
	State space analysis : Solving discrete time state space equations, pulse transfer function, Discretization of continuous time state space equations	3	
	Stability analysis of discrete time systems Jury‘s test	1	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 30 % for theory and 70% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC461	MICROWAVE SOLID STATE DEVICES	3-0-0-3	2015

Prerequisite:
EC403 Microwave & Radar Engineering

Course objectives:

- To study microwave semiconductor devices & applications.
- To study microwave sources and amplifiers.
- To analyse microwave networks
- To introduce microwave integrated circuits

Syllabus:

Limitation of conventional solid state devices at Microwave, Gunn – effect diodes, Microwave generation and amplification, IMPATT and TRAPATT diodes, Bipolar transistors, MESFET, Microwave amplifiers and oscillators, Microwave Network Analysis, Signal flow graphs, Microwave filters, Filter design by image parameter method, Filter transformation and implementation, Introduction to MIC's, Distributed and lumped elements of integrated circuits, Diode control devices

Expected outcome:

Students should be able to understand with active & passive microwave devices & components used in microwave communication systems and analyse microwave networks.

Text Books:

1. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
2. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.
3. David M. Pozar , Microwave Engineering,4/e, Wiley India, 2012

References:

1. Bharathi Bhat and Shiban K. Koul: Stripline-like Transmission Lines for MIC, New Age International (P) Ltd, 1989.
2. I.Kneppo, J.Fabian,etc., Microwave Integrated Circuits,BSP,India,2006.
3. Leo Maloratsky, Passive RF and Microwave Integrated Circuits, Elsevier, 2006.

Course Plan

Module	Course content	Hours	Sem. Exam Marks
I	Introduction, Characteristic, features of microwaves, Limitation of conventional solid state devices at Microwave.	1	15
	Gunn – effect diodes – Gunn effect, Ridley – Watkins-Hilsum theory, Modes of operation, Limited space – Charge accumulation (LSA) mode of Gunn diode.	2	
	Microwave generation and amplification. Structure, Operation, Power output and efficiency of IMPATT and TRAPATT diodes	2	
II	Bipolar transistors – biasing, FET – biasing, MESFET – Structure, Operation.	4	15
	Microwave amplifiers and oscillators – Amplifiers – Gain and stability, Single stage transistor amplifier design.	4	
	Oscillator design – One port negative resistance oscillators.	2	

FIRST INTERNAL EXAM			
III	Microwave Network Analysis – Equivalent voltages and currents, Impedance and Admittance matrices, Scattering matrix, The transmission matrix.	3	**15**
	Signal flow graphs. Impedance matching and tuning – Matching with lumped elements, Single stub tuning, Double stub tuning. Quarter wave transformer, Theory of small reflections.	4	
IV	Microwave filters – Periodic structures – Analysis of infinite periodic structures and terminated periodic structures, Filter design by image parameter method – Constant k, m-derived and composite. Filter design by insertion loss method. Filter transformation and implementation.	7	**15**
SECOND INTERNAL EXAM			
V	Introduction to MIC's:-Technology of hybrid MICs, monolithis MICs. Comparison of both MICs.	4	**20**
	Planar transmission lines such as stripline, microstrip line, slotline etc	**3**	
VI	Distributed and lumped elements of integrated circuits – capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.	**5**	**20**
	Diode control devices – switches, attenuators, limiters. Diode phase shifter. Circulators and isolators.	**2**	
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 70 % for theory and 30% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC 361	**Speech And Audio Signal Processing**	3-0-0-3	**2015**

Prerequisite:EC301 Digital Signal Processing

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

Syllabus: Speech production, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis, Speech coding, Speech recognition, Speech enhancement, Text to speech conversion. Signal Processing Models of Audio Perception, Psycho-acoustic analysis, Spatial Audio Perception and rendering, Audio compression methods, Parametric Coding of Multi-channel audio, Transform coding of digital audio, audio quality analysis.

Expected outcome:

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

Text Books:

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

References:

1. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
3. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1st edition
4. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593
5. Audio Signal Processing and Coding, by Andreas Spanias, Ted Painter and Venkittaram Atti, Wiley-Inter Science publication, 2006
6. Zhouyu Fu; Guojun Lu; Kai Ming Ting; Dengsheng Zhang; , "A Survey of Audio-Based Music Classification and Annotation," Multimedia, IEEE Transactions on, vol.13, no.2, pp.303-319, April 2011doi: 10.1109/TMM.2010.2098858
7. Scaringella, N.; Zoia, G.; Mlynek, D.; "Automatic genre classification of music content: a survey," Signal Processing Magazine, IEEE, vol.23, no.2, pp.133-141, March 2006 doi:10.1109/MSP.2006.1598089
8. Loizou, P. (1998). "Mimicking the human ear," IEEE Signal Processing Magazine, 15(5), 101-130.

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks
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	**15**
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis**,** MFCC. Fundamentals of Speech recognition and Text-to-speech conversion	8	
FIRST INTERNAL EXAM			
III	Speech coding, speech enhancement, Speaker Verification, Language Identification	7	**15**
IV	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	6	**15**
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, psycho-acoustic modelling, adaptive quantization and bit allocation methods, Loss less coding methods.	8	**20**
VI	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Parametric Coding of Multi-channel audio: Mid- Side Stereo, Intensity Stereo, Binaural Cue Coding. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score	8	**20**
END SEMESTER EXAM			

Question Paper

The question paper shall consist of three parts. Part A covers I and II module, Part B covers III and IV module, Part C covers V and VI module. Each part has three questions which may have maximum four subdivisions. Among the three questions one will be a compulsory question covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 50 % for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC465	MEMS	3-0-0 -3	2015

Prerequisite:NIL

Course objectives:

- To understand the operation of major classes of MEMS devices/systems
- To grasp the fundamentals of standard micro fabrication techniques and processes
- To understand the unique demands , environments and applications of MEMS devices
- To create interest for further study in this area

Syllabus:

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

Expected outcome:

The student should be able to:

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

Text Books:

1. Tai-Ran Hsu, *MEMS and Microsystems Design and Manufacture*, TMH, 2002
2. Chang Liu, *Foundations of MEMS*, Pearson 2012

References:

1. Mark Madou, "Fundamentals of Micro fabrication", CRC Press, New York, 1997
2. Stephen D. Senturia, Microsystem design, Springer (India) , 2006.
3. Chang C Y and Sze S M, "VLSI Technology", McGraw-Hill, New York, 2000
4. Julian W Gardner, "Microsensors: Principles and Applications", John Wiley & Sons, 1994
5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks

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.	4	**15**
	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	3	
II	Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses	3	**15**
	Actuation and Sensing techniques : Thermal sensors and actuators, Electrostatic sensors and actuators , Piezoelectric sensors and actuators, magnetic actuators	4	
FIRST INTERNAL EXAM			
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	**15**
IV	Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors,	4	
	Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films, Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemicalvapour deposition – Etching	5	**15**
SECOND INTERNAL EXAM			
V	Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography	6	**20**
	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	3	
VI	Bonding techniques for MEMS : Surface bonding , Anodic bonding , Silicon - on - Insulator , wire bonding , Sealing – Assembly of micro systems	3	**20**
	Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	2	
END SEMESTER EXAM			

Question Paper

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covering both modules and the remaining from each module, of which one to be answered. Mark patterns are as per the syllabus with maximum 70 % for theory and 30% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC467	PATTERN RECOGNITION	3-0-0-3	2015

Prerequisite:
MA201 Linear Algebra & Complex Analysis, MA204 Probability, Random Processes and Numerical Methods,

Course objectives:

- To study the fundamental algorithms for pattern recognition
- To instigate the various classification and clustering techniques

Syllabus: Review of Probability Theory and Probability distributions, Introduction to Pattern Recognition and its applications, Bayesian decision theory, Bayesian estimation: Gaussian distribution, ML estimation, EM algorithm, Supervised and unsupervised learning, Feature selection, Linear Discriminant Functions, Non-parametric methods, Hidden Markov models for sequential data classification, Linear models for regression and classification, Clustering

Expected outcome:
At the end of the course, the student should have a clear understanding of:

1. the design and construction and a pattern recognition system
2. the major approaches in statistical and syntactic pattern recognition.
3. the theoretical issues involved in pattern recognition system design such as the curse of dimensionality.
4. implementing pattern recognition techniques

Text Books

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification and scene analysis, John Wiley
2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer

References

1. Robert J.Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 2007.
2. Tom Mitchell, Machine Learning, McGraw-Hill
3. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.
4. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
5. S.Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Edition, Academic Press, 2009.
6. M. Narasimha Murty, SusheelaDevi,Pattern Recognition:An Introduction,Universities Press, 2011

Course Plan

Module	Course content (42 hrs)	Hours	Marks
I	**Introduction:** Basics of pattern recognition system, various applications, Machine Perception, two main paradigms for pattern recognition problems - statistical and syntactic pattern recognition	3	15%

	Pattern recognition system, Design of Pattern recognition system, Object/process of a Pattern recognition system, Pattern recognition Life Cycle, Cost, Decision concepts and boundaries, Learning & Adaptation.	5	
	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	2	
II	**Parameter estimation methods:** Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation	3	15%
	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	4	
FIRST INTERNAL EXAM			
III	**Non-Parameter methods:** Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method.	4	15%
	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	3	
IV	**Linear Discriminant based algorithm**: Perceptron, Support Vector Machines	6	15%
SECOND INTERNAL EXAM			
V	**Non linear classifiers:** Multilayer perceptrons, Back Propagation algorithm, Artificial Neural networks	4	20%
	Classifier Ensembles: Bagging, Boosting / AdaBoost	2	
VI	**Unsupervised learning:** Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation	6	20%
END SEMESTER EXAM			

Question Paper

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC469	OPTO ELECTRONIC DEVICES	3-0-0-3	2015

Prerequisite:
PH 100 Engineering Physics

Course objectives:

1. Explain the physics of absorption, recombination and photoemission from semiconductors.
2. Analyse different types of photo detectors based on their performance parameters.
3. Discuss different LED structures with material properties and reliability aspects.
4. Explain optical modulators and optical components
5. Illustrate different types of lasers with distinct properties.

Syllabus:

Expected outcome:
After completion of the course the student will be able to

- Explain the property of absorption, recombination and photoemission in semiconductors.
- Illustrate different types of lasers with distinct properties
- Explain different LED structures with material properties
- Analyse different types of photo detectors
- Explain optical modulators and optical components.

Text Books:
1. Pallab Bhattacharya: Semiconductor Optoelectronic Devices, Pearson , 2009
2. Yariv, Photonics Optical Electronics in modern communication,6/e ,Oxford Univ Press,2006.

References:

1. Fundamentals of Photonics : B E Saleh and M C Teich, Wiley-Interscience; 1991
2. Bandyopadhay ,Optical communicatoion and networks.PHI, 2014.
3. Mynbaev ,Scheiner,Fiberoptic Communication Technology, Pearson, 2001.
4. Piprek, Semiconductor Optoelectronic Devices, Elsevier, 2008.
5. Alastair Buckley, Organic Light-Emitting Diodes,Woodhead , 2013.
6. Xun Li, Optoelectronic Devices Design Modelling and Simulaton, Cambridge University Press, 2009

Course Plan

Module	Course content (42hrs)	Hours	Sem. Exam Marks
I	Optical processes in semiconductors – electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination heat generation and dissipation , heat sources.	7	15
II	Lasers – threshold condition for lasing, line broadening mechanisms, axial and transverse laser modes, heterojunction lasers, distributed feedback lasers, DBR lasers, quantum well lasers, tunneling based lasers, modulation of lasers.	7	
FIRST INTERNAL EXAM			

III	Nitride light emitters, nitride material properties, InGaN/GaN LED, structure and working ,performance parameters, InGaN/GaN Laser Diode, structure and working , performance parameters. White-light LEDs, generation of white light with LEDs **,**generation of white light by dichromatic sources, **,**generation of white light by trichromatic sources **,**temperature dependence of trichromatic, **,** 7generation of white light by tetrachromatic and pentachromatic sources,white-light sources based onwavelength converters.	9	**15**
IV	Optical modulators using pn junction, electro-optical modulators, acousto-optical modulators, Raman-Nath modulators, Franz-Keldysh and Stark effect modulators, quantum well electro-absorption modulators, optical switching and logic devices, optical memory .	5	**15**
V	Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, micro cavity photodiodes. Optoelectronic ICs , advantages, integrated transmitters and receivers, guided wave devices. Working of LDR ,liquid crystal display, structure ,TFT display, structure, polymer LED, organic LED.	7	**20**
VI	Introduction to optical components, directional couplers, multiplexers, attenuators, isolators, circulators, tunable filters, fixed filters, add drop multiplexers, optical cross connects, wavelength convertors, optical bistable devices.	7	**20**
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC431	COMMUNICATION SYSTEMS LAB (OPTICAL & MICROWAVE)	0-0-3-1	2015

Prerequisite:
EC403 Microwave & Radar Engineering, EC405 Optical Communication

Course objectives:
To provide experience on design, testing, and analysis of few electronic devices and circuits used for microwave and optical communication engineering.

List of Experiments

Microwave Experiments: (Six mandatory)

1. GUNN diode characteristics.
2. Reflex Klystron Mode Characteristics.
3. VSWR and Frequency measurement.
4. Verify the relation between Guide wave length, 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. Measurement of dielectric constant for given solid dielectric cell.
9. Antenna Pattern Measurement.
10. Study of Vector Network Analyser

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 (APD) and measure the responsivity.
11. Measurement of fiber characteristics, fiber damage and splice loss/connector loss by OTDR.