COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC467	PATTERN RECOGNITION	3-0-0-3	2016

Prerequisite: NIL

Course objectives:

- To introduce 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:

The students will be able to

i. Design and construct a pattern recognition system
ii. Know the major approaches in statistical and syntactic pattern recognition.
iii. Become aware of the theoretical issues involved in pattern recognition system design such as the curse of dimensionality.
iv. Implement pattern recognition techniques

Text Books

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

References

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

Course Plan

Module	Course content	Hours	End Sem Exam Marks
I	**Introduction:** Basics of pattern recognition system, various applications, Machine Perception, classification of pattern recognition systems	3	15%
	Design of Pattern recognition system, Pattern recognition Life Cycle	2	

	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	4	
II	Parameter estimation methods: Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation	2	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 mixture models.	6	
FIRST INTERNAL EXAM			
III	Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method.	3	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	5	15%
SECOND INTERNAL EXAM			
V	Multilayer perceptrons, Back Propagation algorithm, Artificial Neural networks	4	20%
	Classifier Ensembles: Bagging, Boosting / AdaBoost	3	
VI	Unsupervised learning: Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation	5	20%
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC461	MICROWAVE DEVICES AND CIRCUITS	3-0-0-3	2016

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 MICs, Distributed and lumped elements of integrated circuits, Diode control devices

Expected outcome:

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

Text Books:

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

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, et al., Microwave Integrated Circuits, BSP, India, 2006.
3. Leo Maloratsky, Passive RF and Microwave Integrated Circuits, Elsevier, 2006.

Course Plan

Module	Course contents	Hours	End 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 MICSs:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs.	4	**20%**
	Planar transmission lines such as stripline, microstrip line, and slotline.	**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 Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC463	SPEECH AND AUDIO SIGNAL PROCESSING	3-0-0-3	2016

Prerequisite: EC301 Digital Signal Processing

Course objectives:

- To familiarize the basic mechanism of speech production and the basic concepts of methods for speech analysis and parametric representation of speech.
- To give an overall picture about various applications of speech processing
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and rendering.
- To introduce 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:

The students will be able to

i. Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications
ii. Develop systems for various applications of speech processing
iii. Learn Signal processing models of sound perception and application of perception models in audio signal processing.
iv. Implement audio compression algorithms and standards.

Text Books:

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 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. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
3. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
4. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1/e

Course Plan

Module	Course contents	Hours	End 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	**15%**
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%**
SECOND INTERNAL EXAM			
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	**20%**
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	**20%**
END SEMESTER EXAM			

Question Paper Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC465	MEMS	3-0-0 -3	2016

Prerequisite : NIL

Course objectives:

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

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 will be able to:

i. Understand the working principles of micro sensors and actuators
ii. Understand the application of scaling laws in the design of micro systems
iii. Understand the typical materials used for fabrication of micro systems
iv. Understand the principles of standard micro fabrication techniques
v. Appreciate the challenges in the design and fabrication of Micro systems

Text Books:

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

References:

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

Course Plan

Module	Course content (42hrs)	Hours	End 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 Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC469	OPTO ELECTRONIC DEVICES	3-0-0-3	2016

Prerequisite: NIL

Course objectives:

- To know the physics of absorption, recombination and photoemission from semiconductors.
- To analyse different types of photo detectors based on their performance parameters.
- To discuss different LED structures with material properties and reliability aspects.
- To explain optical modulators and optical components
- To illustrate different types of lasers with distinct properties.

Syllabus:

Optical processes in semiconductors – LASERS- Nitride light emitters- White-light LEDs- Optical modulators - optical switching and logic devices, optical memory- Optical detection - Optoelectronic ICs - Introduction to optical components

Expected outcome:

The students will be able to:

i. Explain the property of absorption, recombination and photoemission in semiconductors.
ii. Illustrate different types of lasers with distinct properties.
iii. Explain different LED structures with material properties.
iv. Analyse different types of photo detectors.
v. 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. Alastair Buckley, Organic Light-Emitting Diodes, Woodhead, 2013.
2. B E Saleh and M C Teich, Fundamentals of Photonics:, Wiley-Interscience, 1991
3. Bandyopadhay, Optical communicatoion and networks, PHI, 2014.
4. Mynbaev, Scheiner, Fiberoptic Communication Technology, Pearson, 2001.
5. Piprek, Semiconductor Optoelectronic Devices, Elsevier, 2008.
6. Xun Li, Optoelectronic Devices Design Modelling and Simulation, Cambridge University Press, 2009

Course Plan

Module	Course content (42hrs)	Hours	End 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	15%

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 on wavelength 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%**
SECOND INTERNAL EXAM			
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			

Question Paper Pattern

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