COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC402	NANOELECTRONICS	3-0-0 -3	2016

Prerequisite: EC203 Solid State Devices, EC304 VLSI

Course objectives:

- To introduce the concepts of nanoelectronics.

Syllabus:

Introduction to nanotechnology, Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Schrodinger's Equation, wave function, Low dimensional structures Quantum wells, Basic properties of two dimensional semiconductor nanostructures, Quantum wires and quantum dots, carbon nano tube, grapheme, Introduction to methods of fabrication of nano-layers, Introduction to characterization of nanostructures, Principle of operation of Scanning Tunnelling Microscope, X-Ray Diffraction analysis, MOSFET structures, Quantum wells, modulation doped quantum wells, multiple quantum wells, The concept of super lattices, Transport of charge in Nanostructures under Electric field, Transport of charge in magnetic field, Nanoelectonic devices, principle of NEMS

Expected outcome:

- The students will be able to understand basic concepts of nanoelectronic devices and nano technology.

Text Books:

1. J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006
2. W.R. Fahrner, Nanotechnology and Nanoelctronics, Springer, 2005

References:

1. Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI, 2012
2. George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009.
3. K. Goser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004.
4. Murty, Shankar, Text book of Nanoscience and Nanotechnology, Universities Press, 2012.
5. Poole, Introduction to Nanotechnology, John Wiley, 2006.
6. Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013.

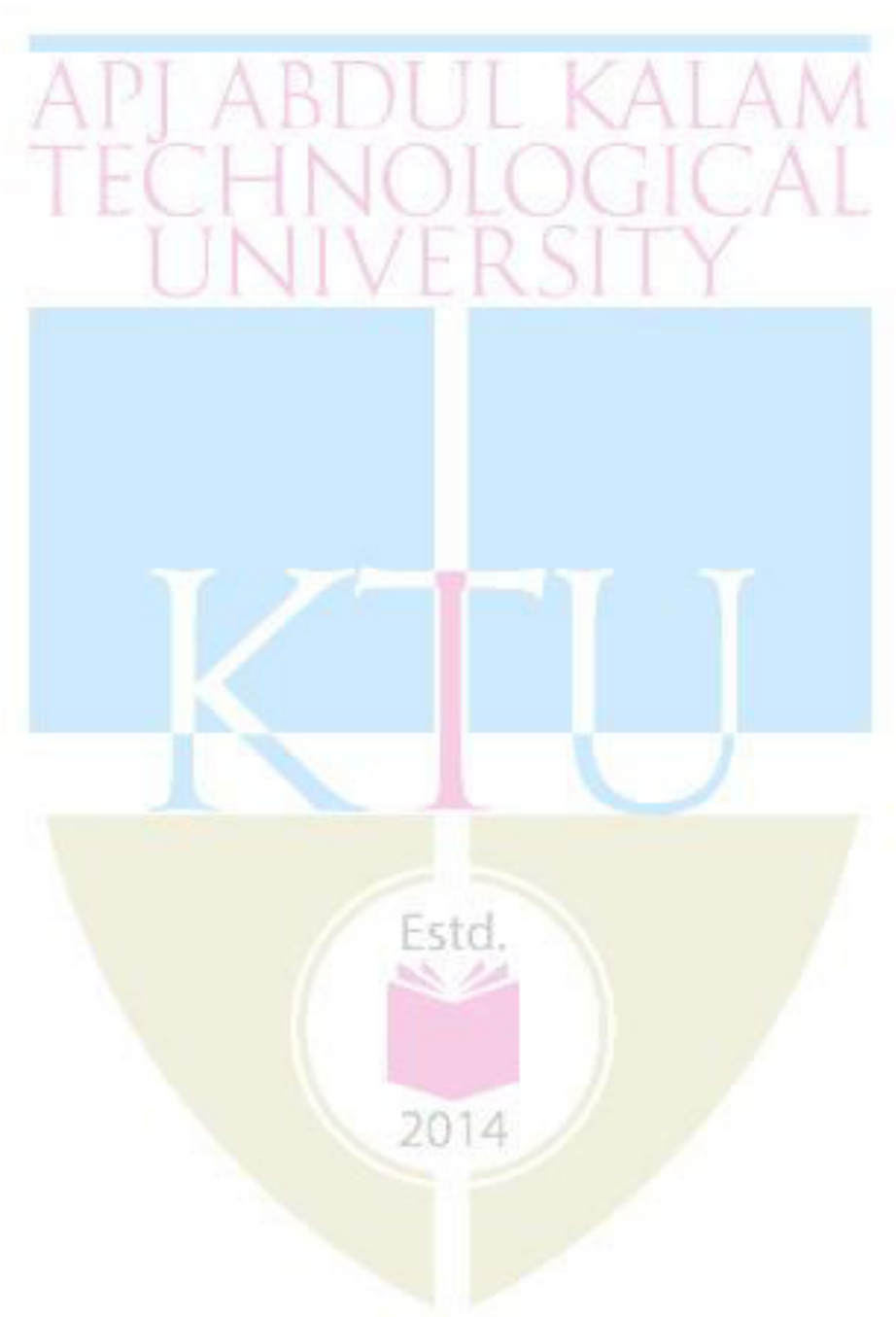
Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to nanotechnology, Impacts, Limitations of conventional microelectronics, Trends in microelectronics and optoelectronics	1	15%
	Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence	2	
	Classification of Nano structures, Low dimensional structures Quantum wells, wires and dots, Density of states and dimensionality	1	

	Basic properties of two dimensional semiconductor nanostructures, square quantum wells of finite depth, parabolic and triangular quantum wells,	2	
	Quantum wires and quantum dots, carbon nano tube, graphene	1	
II	Introduction to methods of fabrication of nano-layers, different approaches, physical vapour deposition, chemical vapour deposition	2	**15%**
	Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods.	2	
	Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.	2	
FIRST INTERNAL EXAM			
III	Introduction to characterization of nanostructures, tools used for of nano materials characterization, microscope-optical, electron, and electron microscope.	2	**15%**
	Principle of operation of Scanning Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope, Specimen interaction. Transmission Electron Microscope	2	
	X-Ray Diffraction analysis, PL & UV Spectroscopy, Particle size analyser.	2	
IV	Two dimensional electronic system, two dimensional behaviour, MOSFET structures, Heterojunctions	2	**15%**
	Quantum wells, modulation doped quantum wells, multiple quantum wells	2	
	The concept of super lattices Kronig - Penney model of super lattice.	2	
V	Transport of charge in Nanostructures under Electric field - parallel transport, hot electrons, perpendicular transport.	2	**20%**
	Quantum transport in nanostructures, Coulomb blockade	2	
	Transport of charge in magnetic field - Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect, the quantum Hall effect.	3	
VI	Nanoelectonic devices- MODFETS, heterojunction bipolar transistors	1	**20%**
	Resonant tunnel effect, RTD, RTT, Hot electron transistors	2	
	Coulomb blockade effect and single electron transistor, CNT transistors	2	
	Heterostructure semiconductor laser	1	
	Quantum well laser, quantum dot LED, quantum dot laser	2	
	Quantum well optical modulator, quantum well sub band photo detectors, principle of NEMS.	2	
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
EC404	ADVANCED COMMUNICATION SYSTEMS	3-0-0 -3	2016

Prerequisite: EC302 Digital Communication, EC403 Microwave & Radar Engineering

Course objectives:

- To impart the basic concepts of various communication system.

Syllabus:

Microwave Radio Communications, Diversity, protection switching arrangements, Digital TV, Satellite communication systems, Satellite sub systems, Evolution of mobile radio communications, Introduction to Modern Wireless Communication Systems, wireless networks, Over view of WIMAX technologies, Cellular concept, Wireless propagation mechanism, Introduction to Multiple Access GSM system architecture, Introduction to new data services

Expected outcome:

- The students will be able to understand the basics and technology of advanced communication system

Text Books:

1. Dennis Roody, Satellite communication, 4/e, McGraw Hill, 2006.
2. Herve Benoit, Digital Television Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework, 3/e, Focal Press, Elsevier, 2008
3. Simon Haykin, Michael Mohar, Modern wireless communication, Pearson Education, 2008
4. Theodore S. Rappaport: Wireless communication principles and practice,2/e, Pearson Education, 1990

References:

1. Jochen Schiller, Mobile Communications, Pearson, 2008.
2. Mishra, Wireless communications and Networks, McGraw Hill, 2/e, 2013.
3. Nathan, Wirelesscommunications,PHI, 2012.
4. Singal, Wireless communications, Mc Graw Hill, 2010.
5. Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson, 2015.
6. W.C.Y.Lee, Mobile Cellular Telecommunication, McGraw Hill, 2010.

Course Plan

Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Microwave Radio Communications : Introduction, Advantages and Disadvantages, Analog vs digital microwave, frequency vs amplitude modulation	1	15%
	Frequency modulated microwave radio system, FM microwave radio repeaters	1	
	Diversity, protection switching arrangements, FM microwave radio stations, microwave repeater station, line of sight path characteristics	2	
II	Digital TV: Digitized Video, Source coding of Digitized Video, Compression of Frames, DCT based (JPED), Compression of Moving Pictures (MPEG). Basic blocks of MPEG2 and MPE4,Digital Video Broadcasting (DVB)	4	15%
	Modulation: QAM (DVB-S, DVB-C), OFDM for Terrestrial Digital TV (DVB –T). Reception of Digital TV Signals (Cable, Satellite and	4	

	terrestrial). Digital TV over IP, Digital terrestrial TV for mobile		
	Display Technologies: basic working of Plasma, LCD and LED Displays	2	
FIRST INTERNAL EXAM			
III	Satellite Communication systems, introduction, Kepler's laws, orbits, orbital effects, orbital perturbations	2	**15%**
	Satellite sub systems, Antennas, Transponders, earth station technology, Link calculation,	2	
	Satellite systems- GEO systems, non-GEO communication systems, Satellite Applications- Global Positioning System, Very Small Aperture Terminal system, Direct to Home Satellite Systems	3	
IV	Evolution of mobile radio communications, paging systems, Cordless telephone systems, comparison of various wireless systems	2	**15%**
	Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks, fourth generation wireless technologies	1	
	Wireless in local loop, wireless local area networks, Blue tooth and Personal Area networks, Over view of WIMAX Technologies, architecture, spectrum allocation	2	
SECOND INTERNAL EXAM			
V	Cellular concept, hand off strategies, Interference and system capacity: Cell splitting, Sectoring, Repeaters, and Microcells. Cellular System Design Fundamentals: Frequency Reuse, channel assignment strategies, handoff Strategies, Interference and system capacity, tracking and grade off service, improving coverage and capacity	3	**20%**
	Wireless propagation mechanism, free space propagation model, ground reflection model, knife edge diffraction model, path loss prediction in hilly terrain, introduction to fading and diversity techniques, Introduction to MIMO system	3	
VI	Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, CDMA, OFDM	2	**20%**
	Wireless Networking, Difference between wireless and fixed telephone networks, development of wireless networks, fixed network transmission hierarchy, traffic routing in wireless networks, wireless data services, Wireless standards,	2	
	GSM system architecture, radio link aspects, network aspects	1	
	Introduction to new data services like High Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), Digital Enhanced Cordless Telecommunications (DECT) , Enhanced Data Rate for Global Evolution (EDGE), Ultra wideband systems (UWB), Push To Talk (PTT) technology, Mobile IP	5	
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 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC462	MIXED SIGNAL CIRCUIT DESIGN	3-0-0 -3	2016

Prerequisite: EC 304 VLSI, EC308 Embedded Systems

Course objectives:

- To give the knowledge about various analog and digital CMOS circuits
- To impart the skill in analysis and design of analog and digital CMOS circuits.

Syllabus:

CMOS Amplifiers**:** CS,CG,CD stages, Cascoded stages, Folded cascode Amplifier, MOS Current Mirror, MOSFET cascode current mirror, Differential Amplifiers, MOS telescopic cascode amplifier,CMOS OP AMPS, Design of classical Two Stage OP AMP, Comparator, Band gap References, Phase Locked Loop, Dynamic analog circuits, Data Converters, Switched Capacitor Circuits, Data Converters- Specifications, DAC, ADC Architecture

Expected outcome:

The students will be able to design and analyse various analog and digital CMOS circuits.

Text Books:

1. Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004.
2. Razavi B., Fundamentals of Microelectronics, Wiley student Edition2014.

References:

1. Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, Prentice Hall India, 2000
2. Razavi B., Design of Analog CMOS Integrated Circuits, Mc Graw Hill, 2001.

Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	**CMOS Amplifiers-** Common Source with diode connected loads and current source load, CS stage with source degeneration, CG stage and Source Follower (Only Voltage Gain and Output impedance of circuits)	4	**15%**
	Cascoded stages - Cascoded amplifier, Cascoded amplifier with cascoded loads , Folded cascode Amplifier	4	
II	**MOS Current Mirror**- Basic circuit, PMOS and NMOS current mirrors Current mirror copying circuits, MOSFET cascode current mirror circuits	3	**15%**
	Differential Amplifiers-Differential Amplifier with MOS current source Load, with cascaded load and with current mirror load, MOS telescopic cascode amplifier. (Only Voltage Gain and Output impedance of circuits)	4	
FIRST INTERNAL EXAM			
III	**CMOS OP AMPS-** Two Stage Operational Amplifiers - Frequency compensation of OPAMPS - miller compensation**,**	3	**15%**

	Design of classical Two Stage OP AMP		
	Comparator- Characterization of a comparator-static and dynamic, A Two stage open loop comparator (analysis not required)	3	
IV	**Band gap References-** Supply Independent Biasing, Temperature independent references –band gap reference	5	**15%**
	Phase Locked Loop – Simple PLL ,Basic PLL Topology, Charge Pump PLL, Basic Charge Pump PLL	3	
SECOND INTERNAL EXAM			
V	**Dynamic analog circuits** – charge injection and capacitive feed through in MOS switch, Reduction technique	3	**20%**
	Switched Capacitor Circuits- sample and hold circuits, Switched Capacitor Integrator, Ladder filters	3	
VI	**Data Converters-** DAC Specifications-DNL, INL, latency, SNR, Dynamic Range ADC Specifications-Quantization error, Aliasing, SNR, Aperture error	4	**20%**
	DAC Architecture - Resistor String, Charge Scaling and Pipeline types. **ADC Architecture-** Flash and Pipe line types	3	
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 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC466	CYBER SECURITY	3-0-0 -3	2016

Prerequisite: EC407 Computer Communication

Course objectives:

- To familiarize various types of cyber-attacks and cyber-crimes.
- To give an overview of the cyber laws
- To study the defensive techniques against these attacks

Syllabus:

Vulnerability scanning, tools for scanning, Network defense tools, Firewalls and Intrusion Detection Systems, Virtual Private Networks, Scanning for web vulnerabilities tools, Cyber crimes and law, cyber crime investigation

Expected outcome:

The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks

Text Books:

1. Mike Shema , Anti-Hacker Tool Kit, Mc Graw Hill
2. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley

References:

1. Achyut S.Godbole Data Communication and Networking,2e, McGraw –Hill Education New Delhi,2011
2. Forouzan, Data Communication and Networking (Global Edition) 5/e, McGraw Hill Education India, 2013.
3. Forouzan,TCP/IP Protocol Suite 4e, McGraw Hill Education India, 2010

Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	**Introduction to Vulnerability Scanning** Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit.	7	15%
II	**Network Vulnerability Scanning** Networks Vulnerability Scanning - Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools, Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping, Kismet	7	15%
	FIRST INTERNAL EXAM		
III	**Network Defense tools** Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection	8	15%

IV	**Web Application Tools** Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools – John the Ripper, L0htcrack, Pwdump, HTC-Hydra	6	**15%**
SECOND INTERNAL EXAM			
V	**Introduction to Cyber Crime and law** Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.	8	**20%**
VI	**Introduction to Cyber Crime Investigation** Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks	6	**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 100% for theory.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC464	LOW POWER VLSI	3-0-0 -3	2016

Prerequisite: EC 304 VLSI, EC308 Embedded Systems

Course objectives:

- To identify the power dissipation mechanisms in various MOS logic styles
- To familiarize suitable techniques to reduce power dissipation

Syllabus:

Physics of Power dissipation in MOSFET devices, Sources of power dissipation in CMOS, Circuit techniques for leakage power reduction, Design and test of low voltage CMOS, Non clocked circuit design style, Adiabatic switching.

Expected outcome:

The students will be able to:

i. Identify the sources of power dissipation in digital IC systems.
ii. Understand the impact of power on system performance and reliability
iii. Understand leakage sources and reduction techniques
iv. Recognise advanced issues in VLSI systems, specific to the deep-submicron silicon technologies
v. Identify the mechanisms of power dissipation in CMOS integrated circuits

Text Books:

1. Gray Yeap, Practical low power digital VLSI design, Springer, 1998
2. Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000

References:

1. Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995
2. Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995
3. Christian Piguet, Low power CMOS circuits, Taylor & Francis, 2006
4. Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004

Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	**Physics of Power dissipation in MOSFET devices** MIS structure, Need for low power circuit design	2	15%
	Threshold voltage, body effects,	1	
	Short channel effects-surface scattering, punch through, velocity saturation, impact ionization	2	
	Hot electron effects, drain induced barrier lowering, narrow width effects	2	
II	**Sources of power dissipation in CMOS**-Switching power dissipation,	2	15%
	Short circuit power dissipation, glitching power dissipation	2	
	Leakage power dissipation, Transistor leakage mechanisms of	3	

	deep submicron transistors		
FIRST INTERNAL EXAM			
III	**Circuit techniques for leakage power reduction** – standby leakage control using transistor stacks	2	**15%**
	multiple V_{th} techniques, Dynamic V_{th} techniques	2	
	supply voltage scaling techniques, Deep submicron devices design issues	2	
	Minimizing short channel effect	2	
IV	**Design and test of low voltage CMOS** – Circuit design style- clocked design style- Basic concept	2	**15%**
	Domino logic (domino NAND gate)	1	
	Differential Current Switch Logic.	2	
SECOND INTERNAL EXAM			
V	**Non clocked circuit design style**-fully complementary logic	2	**20%**
	NMOS and pseudo –NMOS logic	2	
	differential cascade voltage switch logic(DCVS),	2	
	pass transistor logic	2	
VI	**Adiabatic switching** – Adiabatic charging, adiabatic amplification	2	**20%**
	One stage and two stage adiabatic buffer	2	
	fully adiabatic system	1	
	Adiabatic logic gates, pulsed power supplies	2	
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 60% for theory and 40% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC468	SECURE COMMUNICATION	3-0-0 -3	2016

Prerequisite: EC407 COMPUTER COMMUNICATION

Course objectives:

•To impart the students about the theory and technology behind the secure communication.

Syllabus:

Introduction on Security, Security Goals, Types of Attacks, Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p), Polynomial arithmetic, Symmetric Ciphers, Symmetric Cipher Model, Substitution Techniques, Transposition techniques, Block Ciphers, Data encryption Standards, Differential and Linear Crypt analysis Advanced Encryption standard, The AES Cipher, Public key cryptosystem, RSA algorithm, Intruders, Password management

Expected outcome:

The student will be

i. Exposed to the different approaches that handle security and the algorithms in use for maintaining data integrity and authenticity.

ii. Enabled student to appreciate the practical aspects of security features design and their implementation

Text Books:

1. Behrouz A. Forouzan , Cryptography and Network security Tata McGraw-Hill, 2008
2. William Stallings, Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India, New Delhi, 2002

References:

1. David S. Dummit & Richard M Foote, Abstract Algebra, 2nd Edition, Wiley India Pvt. Ltd., 2008.
2. Douglas A. Stinson, Cryptography, Theory and Practice, 2/e, Chapman & Hall, CRC Press Company, Washington, 2005.
3. Lawrence C. Washington, Elliptic Curves: Theory and Cryptography, Chapman & Hall, CRC Press Company, Washington, 2008.
4. N. Koeblitz: A course in Number theory and Cryptography, 2008
5. Thomas Koshy: Elementary Number Theory with Applications, 2/e, Academic Press, 2007
6. Tyagi and Yadav , Cryptography and network security, Dhanpatrai, 2012

Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction on security, security goals and types of attacks: Passive attack, active attack, attacks on confidentiality, attacks on integrity and availability, Security services and mechanisms.	5	15%
II	Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p)	4	15%
	Polynomial arithmetic: Finite fields of the form GF (2n).	4	
	FIRST INTERNAL EXAM		
III	Symmetric Ciphers, Symmetric Cipher Model	3	15%

	Substitution Techniques, Caesar Cipher, Mono alphabetic Cipher, Play fair cipher, Hill cipher, Poly alphabetic Cipher, one time pad	4	
IV	Transposition techniques ,Block Ciphers, Data encryption Standards, DES Encryption, DES decryption	3	**15%**
	Differential and Linear Crypt analysis Advanced Encryption standard	2	
	The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation.	2	
SECOND INTERNAL EXAM			
V	Public key cryptosystem, Application for Public key cryptosystem requirements	2	**20%**
	RSA algorithm, Key management, Distribution of public key, public key certificates, Distribution of secret keys.	5	
VI	Intruders: Intrusion techniques, Intrusion detection, Statistical anomaly detection, Rule based intrusion detection, Distributed intrusion detection, Honey pot, Intrusion detection exchange format.	5	**20%**
	Password management: Password protection, password selection strategies.	2	
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 50% for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC472	INTEGRATED OPTICS & PHOTONIC SYSTEMS	3-0-0 -3	2016

Prerequisite: EC303 Applied Electromagnetic Theory, EC405 Optical Communication

Course objectives:

- To discuss basic goals, principles and techniques of integrated optical devices and photonic systems
- To explain operation and integration of various optoelectronic devices in an integrated optical system
- To study about various components like optical waveguides, optical couplers, design tools, fabrication techniques, and the applications of optical integrated circuits.
- To introduce some of the current state-of-the-art devices and systems.

Syllabus: Review of Electromagnetics: Maxwell's equations, optical waveguides and devices, Waveguide Fabrication Techniques, Electro-Optic Waveguides, Polymer Waveguide Device, Losses in optical wave guide, Wave guide input and output couplers, coupled mode theory, Light Propagation in Waveguides, FFT-BPM, FD-BPM, Electro-Optic Modulators: Types, Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, applications of optical integrated circuits, devices and systems for telecommunications, microwave carrier generation by optical techniques, photonic crystals, nanophotonic device.

Expected outcome:

The student will have an in depth knowledge of

i. Devices that are basic components of integrated optics and photonic systems including Optical wave guides, optical couplers, Lasers, Detectors and modulators
ii. Light propagation in waveguides
iii. The fabrication process of Optical Integrated devices
iv. Applications of Optical Integrated devices
v. Nano photonic devices

Text Books:

1. Lifante, Integrated Photonics: Fundamentals, John Wiley 2003
2. Robert Hunsperger, Integrated optics :Theory and technology 6/e Springer, 2009

References:

1. H. Nishihara, M. Haruna, and T. Suhara, Optical Integrated Circuits, McGraw-Hill Professional, 1989.
2. KeicoIizuka, Elements of photonics, John Wiley, 2002 .
3. Pappannareddy, Introduction to light wave systems,Artech House,1995

RELATED LINKS

Website of IEEE photonics society: www.ieee.org/photonics.

Course Plan

Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Review of Electromagnetics , Maxwell's equations - Wave equation	3	15%
	Analysis of optical waveguides and devices- Planar waveguides, chanel waveguides, graded index waveguides.	4	

II	Waveguide Fabrication Techniques -substrate materials for optical IC , Epitaxially Grown Waveguides- Electro-Optic Waveguides	4	**15%**
	Types of Polymers-Polymer Waveguide Devices, Optical Fiber Waveguide Devices	3	
FIRST INTERNAL EXAM			
III	Losses in optical wave guide, measurement of losses. Wave guide input and output couplers, types of couplers, coupling between wave guides,	4	**15%**
	Optical Fiber Couplers and Splitters, coupled mode theory	3	
IV	Light Propagation in Waveguides: The Beam Propagation Method-Fresnel Equation - Fast Fourier Transform Method (FFT-BPM) - Solution based on discrete fourier transform - Method Based on Finite Differences (FD-BPM), Boundary Conditions	7	**15%**
SECOND INTERNAL EXAM			
V	Electro-Optic Modulators - Basic Operating Characteristics- The Electro-Optic Effect,Mach-Zehnder Modulator, acousto-optic modulator,	4	**20%**
	Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, structures.	3	
VI	Applications of Optical Integrated Circuits-Spectrum Analyser-Temperature and High Voltage Sensors,	3	**20%**
	Devices and Systems for Telecommunications- Microwave Carrier Generation by Optical Techniques, - Photonic Crystals-Nanophotonic Device.	4	
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 50% for theory and 50% for logical/numerical problems, derivation and proof.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016

Prerequisite : Nil

Course Objectives

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

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.