Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. V Semester

Electronics & Communication Engineering

Rajasthan Technical University, Kota

Effective from session: 2022 – 2023

5EC3-01: Computer Architecture

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Basic Structure of Computers, Functional units, software, performance issues software, machineinstructions and programs, Types of instructions, Instruction sets: Instruction formats,Assembly language, Stacks, Ques, Subroutines.	6
3	Processor organization, Information representation, number formats. Multiplication & division, ALU design, Floating Point arithmetic, IEEE 754 floating pointformats.	5
4	Control Design, Instruction sequencing, Interpretation, Hard wired controlDesignmethods, and CPU control unit. Microprogrammed Control - Basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit.	6
5	Memory organizations, device characteristics, RAM, ROM, Memory management, Concept ofCache & associative memories, Virtual memory.	5
6	System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfacesConcept of parallel processing, Pipelining, Forms of parallel processing, interconnect network.	5
	Total	28

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5EC4-02: Electromagnetics Waves

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Transmission Lines-Equations of Voltage and Current on TXline, Propagation constant and characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TXline, Smith Chart, Admittance Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections ascircuit elements.	08
3	Maxwell's Equations-Basics of Vectors, Vector calculus, Basic laws of Electromagnetics,Maxwell's Equations, Boundary conditions at Media Interface.	03
4	Uniform Plane Wave-Uniform plane wave, Propagation of wave, Wave polarization, Poincare's Sphere, Wave propagation in conducting medium, phase and group velocity, Power flow and Poynting vector, Surface current and power loss in a conductor.	08
5	Plane Waves at a Media Interface-Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary.	07
6	Waveguides- Wave propagation in parallel plate waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.	08
7	Radiation-Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna.	07
	Total	42

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Rajasthan Technical University, Kota

5EC4-03: Control system

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulicservomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.	8
3	Feedback control systems- Stability, steady-state accuracy,transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feedforward and multi-loop control configurations, stability concept, relative stability, Routhstability criterion.	7
4	Time response of second-order systems- steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.	6
5	Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquistplots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation andsolution.	8
6	State variable Analysis- Concepts of state, state variable, state model, state modelsfor linearcontinuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.	6
7	Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, treking problem. Nonlinear system – Basic concept &analysis.	6
	Total	42

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Rajasthan Technical University, Kota

5EC4-04: Digital Signal Processing

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LSI systems, frequency Analysis, Inverse Systems.	10
3	Discrete Fourier Transform (DFT), Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems.	9
4	Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR DigitalFilters: Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.	10
5	Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to mult-irate signal processing. Application of DSP.	10
	Total	40

5EC4-05: Microwave Theory & Techniques

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to Microwaves-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC.	4
3	Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated withmicrowave transmission, Concept of Impedance in Microwave transmission.	5
4	Analysis of RF and Microwave Transmission Lines-Coaxial line, Rectangularwaveguide, Circular waveguide, Strip line, Micro strip line.	4
5	Microwave Network Analysis-Equivalent voltages and currents for non-TEMlines, Networkparameters for microwave circuits, Scattering Parameters.	4
6	Passive and Active Microwave Devices-Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator.Microwave active components: Diodes, Transistors, Oscillators, Mixers.Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes.MicrowaveTubes: Klystron, TWT, Magnetron.	6
7	Microwave Design Principles-Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. Microwave Antennas- Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas.	6
8	Microwave Measurements-Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzerand measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.	6
9	Microwave Systems-Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation, RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.	6
	Total	**42**

5EC5-11: Bio-Medical Electronics

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Brief introduction to human physiology. Biomedical transducers: displacement,velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases.	9
3	Bio-electrodes and biopotential amplifiers for ECG, EMG, EEG, etc.	7
4	Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging.Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.	11
	Total	**28**

5EC5-12: Embedded Systems

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	The concept of embedded systems design, Embedded microcontroller cores, embedded memories.	5
3	Examples of embedded systems, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub system interfacing, interfacing with external systems, user interfacing.	10
4	Design tradeoffs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.	12
	Total	28

5EC5-13: Probability Theory & Stochastic Process

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.	5
3	Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;	6
4	Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;	6
5	Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem	5
6	Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.	4
	Total	27

5EC5-14: Satellite Communication

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to Satellite Communication: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.	4
3	Orbital Mechanics: Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day.	4
4	Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems etc.	5
5	Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift. Satellite link budget	5
6	Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.	4
7	Modulation and Multiple Access Schemes: Various modulation schemes used in satellite communication, Meaning of Multiple Access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA.	4
	Total	**27**

5EC4-21: RF Simulation Lab

Credit:1.5 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+3P **End Term Exam: 2Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Study of field pattern of various modes inside a rectangular and circular waveguide.
3	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials embedded between two conductors.
4	Design and simulate the following Planar Transmission Lines: I. Strip and micro-striplines II. Parallel coupled stripline III. Coplanar and Slotlines Determine their field patterns and characteristic impedance.
5	Design and simulate the following: I. 3-dB branch linecoupler II. Wilkinson powerdivider III. Hybridring IV. Backward wavecoupler V. Low passfilters VI. Band passfilters
6	Design RF amplifier using microwave BJT.
7	Design RF amplifier using microwave FET.

5EC4-22: Digital Signal Processing Lab

Credit:1.5 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+3P **End Term Exam: 2Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Generation of continuous and discrete elementary signals (impulse,unit-step,ramp) using mathematical expression.
3	Perform basic operations on signals like adding, subtracting, shifting and scaling.
4	Perform continuous and discrete time Convolution (using basic definition).
5	Checking Linearity and Time variance property of a system using convolution, shifting.
6	To generate and verify random sequences with arbitrary distributions, means and variances for following: (a) Rayleighdistribution (b) Normal distributions:N(0,1). (c) Gaussion distributions: N (m,x) (d) Random binarywave.
7	To find DFT / IDFT of given DT signal.
8	N-point FFT algorithm.
9	To implement Circular convolution.
10	MATLAB code for implementing z-transform and inverse z-transform.
11	Perform inverse z-transform using residuez MATLAB function.
12	MATLAB program to find frequency response of analog LP/HP filters.
13	To design FIR filter (LP/HP) using windowing (rectangular, triangular, Kaiser) technique using simulink.

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5EC4-23: Microwave Lab

Credit:1 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+2P **End Term Exam: 2Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Study of various microwave components and instruments like frequency meter, attenuator, detector and VSWRmeter. (a) Measurement of guide wavelength and frequency using a X-band slotted line setup. (b) Measurement of low and high VSWR using a X-band slotted linesetup.
3	Introduction to Smith chart, measurement of SWR, shift in minimum standing wave with unknown load and calculation of unknown load impedance using Smith chart.
4	Study the behavior of terminated coaxial transmission lines in time and frequency domain.
5	(a) Draw the V-I characteristics of a Gunn diode and determine the output power and frequency as a function ofvoltage. (b) Study the square wave modulation of microwave signal using PINdiode.
6	Study the square wave modulation of microwave signal using PIN diode.Study and measure the power division and isolation characteristics of a microstrip 3dB power divider.
7	Study of rat race hybrid ring (equivalent of waveguide Magic-Tee) in micro-strip.
8	(a) To study the characteristics of micro-strip 3dB branch line coupler, strip line backward wave coupler as a function of frequency and compare theirbandwidth. (b) (b)Measure the microwave input, direct, coupled and isolated powers of a backward wave strip line coupler at the centre frequency using a power meter. From the measurements calculate the coupling, isolation and directivity of thecoupler.

Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Electronics & Communication Engineering

Rajasthan Technical University, Kota

Effective from session: 2022-23

6EC3-01: Power Electronics

Credit:2 **Max. Marks: 100(IA:30,ETE:70)**
2L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	SEMICONDUCTOR POWER DEVICES: Introduction. Basic characteristics &working of Power Diodes, Diac, Triac, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-On mechanism and itsapplications.	6
3	CONVERTERS: Basic concept, Working Principles of Single phase half Wave bridge converter, Single Phase Full Bridge Converter, 3 Phase Bridge Converter.	5
4	INVERTERS: Voltage Source Inverter, Current Source Inverter, PWM Control of Voltage Source Converter and applications.	5
5	INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers. Chopper control techniques, High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter. Uninterruptible PowerSupply.	6
6	MOTOR CONTROL: Introduction to speed control of DC motors using phase controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods.	5
	Total	**28**

6EC4-02: Computer Network

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Queuing Theory- Pure birth, Pure death & Birth-death processes, Mathematical models for M/M/1, M/M/ ∞, M/M/m, M/M/1/Kand M/M/m/m queues. Little's formula.	7
3	Introduction to computer networks and the Internet: Application layer: Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic ail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering concepts. Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, StatisticalMultiplexing.	9
4	Transport layer: Connectionless transport - User Datagram Protocol, Connection oriented transport – Transmission Control Protocol, Remote Procedure Call. Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.	9
5	Network layer: Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing.	7
6	Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, Switches. Fundamental of SDN, Open flow.	7
	Total	40

6EC4-03: Fiber Optics Communications

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to vector nature of light, propagation of light, propagation of light in a cylindricaldielectric rod, Ray model, wave model.Different types of optical fibers, Modal analysis of a step index fiber.	8
3	Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers andmeasurement techniques like OTDR	7
4	Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detectorresponsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.	8
5	Optical switches - coupled mode analysis of directional couplers, electro-optic switches.Optical amplifiers - EDFA, Raman amplifier.	8
6	WDM and DWDM systems. Principles of WDM networks.Nonlinear effects in fiber optic links. Concept of self-phase modulation, groupvelocity dispersion and solition basedcommunication.	8
	Total	40

6EC4-04: Antennas and Propagation

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**

3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Fundamental Concepts-Physical concept of radiation, Radiation pattern, near andfar-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.	7
3	Radiation from Wires and Loops-Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.	6
4	Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.	7
5	Broadband Antennas-Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.	5
6	Micro strip Antennas-Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.	6
7	Antenna Arrays-Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkun off polynomial method, Woodward-Lawsonmethod.	5
8	Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, fixed weight beamforming basics, Adaptive beam forming.	4
9	Different modes of Radio Wave propagation used in current practice.	1
	Total	42

6EC4-05: 5G Communication Technology

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

Unit	Topic	
1	**Introduction:** Introduction of 3G and 4G (LTE, LTEA, LTEA Pro), 5G overview , requirements, Spectrum access modes and Sharing for 5G . **Channel Modeling** : Channel modeling requirements, propagation scenarios and challenges in the 5G modeling	4
2	**System Architecture**: 5G core network architecture, Radio Accesses Network (RAN) architectures, Interference management, mobility management and handover in 5G. **Physical Layer and Deployment:** 5G Physical channels , signals and frame structure ; Small cell deployments: different types, Deployment scenarios, performance and analysis, 3GPP RAN standards for small cell	8
3	**Modulation and Accesses Techniques** : Orthogonal frequency division multiplexing (OFDM), filter bank multi-carriers (FBMC) , orthogonal frequency division multiple accesses (OFDMA), non-orthogonal multiple accesses (NOMA)	5
4	**Device-to-device (D2D) and machine-to-machine (M2M) type communications:** Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications	5
5	**Millimeter-wave Communications**: Millimeter bands, radio-wave propagation, Physical layer design, beam-forming, interference and mobility management ; Massive MIMO(Sub 6Ghz) -mm wave MIMO (above 6GHz), Smart Antennas for 5G	8
6	**5G Network Slicing**: Introduction of Network Slicing, E2E Slicing, SDN and NFV Slicing **Vehicular Communication:** From V2V to AV2X, key standards, VC architectures basics	6
	Total Lectures 40	

Text books

1. Martin Sauter, From GSM to LTE—Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Wiley-Blackwell
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, Fundamentals of 5G Mobile Networks , Cambridge University Press
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, New Directions in Wireless Communication Systems from Mobile to 5G, CRC Press
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock, Millimeter Wave Wireless Communications, Prentice Hall Communications

Reference Books

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons
2. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015
3. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019
4. Principles of Modern Wireless communication systems by Aditya k Jagannathan
5. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021
6. Erik Dahlman, Stefan and Parkvall, Johan Skoid, 5G NR: The Next Generation Wireless Access Technology, Elsevier, First Edition, 2016
7. Harri Holma, Antti Toskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley & Sons First Edition,2020

6EC5-11: Introduction to MEMS

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction and Historical Background.	1
3	Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.	14
4	Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.	14
5	Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding.	10
	Total	40

6EC5-12: Nano Electronics

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction to nanotechnology, meso structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig-Penny Model. Brillouin Zones.	15
3	Shrink-down approaches: Introduction, CMOS Scaling, The nano scale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issuesetc.).	10
4	Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation.	14
	Total	40

6EC5-13: Neural Network And Fuzzy Logic Control

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	**NEUROPHYSIOLOGY:** Introduction: Elementary neurophysiology – From neurons to ANNs - Neuron model McCulloch-Pitts model, Hebbian Hypothesis; limitations of single-layered neural networks. Applications Of Neural Networks: Pattern classification, Associative memories, Optimization,ApplicationsinImageProcessing-Iris,fingerprint&face, Applications in decision making.	8
3	**THE PERCEPTRON:** The Perceptron and its learning law. Classification of linearly separable patterns. Linear Networks: Adaline - the adaptive linear element. Linear regression. The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Feed forward Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back-Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Nettalk.	9
4	**FUZZY LOGIC:** Introduction -Uncertainty & precision, Statistics and random process, Uncertainty in information, Fuzzy sets and membership. Membership Functions: Features of membership function. Standard forms and boundaries, Fuzzification, Membership value assignment – Intuition, Inference, Neural networks. Fuzzy To Crisp Conversions: Maximum membership principle.	7
5	**DEFUZZIFICATION METHODS-** Centroid method, Weighted average method, Meanmax membership. Fuzzy Rule Based Systems: Natural language, linguistic hedges, Rule based system –Canonical rule forms, Decomposition of compound rules, Likelihood and truth qualification Aggregation of Fuzzy rules. Graphical techniques of reference.	8
6	**FUZZY CONTROL SYSTEM-** Simple Fuzzy Logic controller, General FLC, Control System Design Problem Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Special forms of FLC system models, Industrial application: Aircraft Landing Control Problem. Fuzzy Engineering Process Control: Classical Feedback Control, Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems, Fuzzy Statistical Process Control.	9
	Total	42

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6EC5-14: High Speed Electronics

Credit:3 **Max. Marks: 100(IA:30,ETE:70)**
3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Transmission line theory (basics) crosstalk and nonideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency powerdelivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise; Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Intermodulation, Cross-modulation, Dynamic range.	10
3	Devices: Passive and active, Lumped passive devices (models), Active (models, low vs High frequency)	6
4	RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed)Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages.	8
5	Mixers –Up conversion Down conversion, Conversion gain and spurious response. OscillatorsPrinciples.PLL Transceiver architectures.	8
6	Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.	8
	Total	41

6EC4-21: Computer Network Lab

Credit:2 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+4P **End Term Exam: 2Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	PRELIMINARIES: Study and use of common TCP/IP protocols and term viz. telnet rlogin ftp, ping, finger, Socket, Port etc.
3	DATA STRUCTURES USED IN NETWORK PROGRAMMING: Representation of unidirectional, Directional weighted and unweighted graphs.
4	ALGORITHMS IN NETWORKS: computation of shortest path for one source-one destination and one source –all destination
5	SIMULATION OF NETWORK PROTOCOLS: i. Simulation of M/M/1 and M/M/1/Nqueues. ii. Simulation of pure and slottedALOHA. iii. Simulation of link state routingalgorithm.
6	Case study : on LAN Training kit i. Observe the behaviour & measure the throughput of reliable data transfer protocols under various Bit error rates for following DLL layerprotocols- a. Stop &Wait b. Sliding Window : Go-Back-N and SelectiveRepeat ii. Observe the behaviour & measure the throughput under various network load conditions for following MAC layerProtocols a. Aloha b. CSMA, CSMA/CD &CSMA/CA c. Token Bus & TokenRing
7	Software and hardware realization of the following: i. Encoding schemes: Manchester,NRZ. ii. Error control schemes: CRC, Hammingcode.

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6EC4-22: Antenna and Wave Propagation Lab

Credit:1 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+2P **End Term Exam: 2Hours**

SN	Contents
	PART-I (Antenna)
1	Study the gain pattern, HPBW, FNBW and Directivity of a dipole antenna.
2	Measurement of Radiation Pattern, Gain, HPBW of a folded dipole antenna.
3	Measurement of Radiation Pattern, Gain, HPBW of a loop antenna
4	Measurement of Radiation Pattern, Gain, VSWR, input impedance and reflection coefficient for given Monopole antenna
5	Measurement of Radiation Pattern,Gain,VSWR, input impedance and reflection coefficient for given Yagiantennas
6	Study of the Radiation Pattern, Gain, HPBW of a horn antenna
7	Study of the Radiation Pattern, Gain, HPBW of a reflector antennas
8	Study the radiation pattern, gain, VSWR, and input impedance of a rectangular microstrip patch antenna
9	Study the effect of inset feed on the input impedance of a rectangular patch antenna
10	Study the effect of ground plane on the radiation pattern of an antenna
11	Study antenna designing in CST Microwave Studio
12	Design a rectangular micro strip patch antenna using CST MWS
	PART-II (Optical Fiber) To perform following experiments based on Fiber Optic Trainer.
13	To set up Fiber Optic Analog link and Digital link.
14	Measurement of Propagation loss and numerical aperture.

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6EC4-23: Electronics Design Lab

Credit:2 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+4P **End Term Exam: 2Hours**

SN	Contents
	To design the following circuits, assemble these on bread board and test them and Simulation of these circuits with the help of appropriate software.
1	Op-Amp characteristics and get data for input bias current measure the output-offset voltage and reduce it to zero and calculate slew rate.
2	Op-Amp in inverting and non-inverting modes.
3	Op-Amp as scalar, summer and voltage follower.
4	Op-Amp as differentiator and integrator.
5	Design LPF and HPF using Op-Amp 741
6	Design Band Pass and Band reject Active filters using Op-Amp 741.
7	Design Oscillators using Op-Amp (i) RC phase shift (ii) Hartley (iii) Colpitts
8	Design (i) Astable (ii) Monostable multivibrators using IC-555 timer
9	Design Triangular & square wave generator using 555 timer.
10	Design Amplifier (for given gain) using Bipolar Junction Transistor.
11	Op-Amp characteristics and get data for input bias current measure the output-offset voltage and reduce it to zero and calculate slew rate.
12	Op-Amp in inverting and non-inverting modes.
13	Op-Amp as scalar, summer and voltage follower.

6EC4-24: Power Electronics Lab

Credit:1 **Max. Marks: 100(IA:60,ETE:40)**
0L+0T+2P **End Term Exam: 2Hours**

SN	Contents
1	Study the characteristics of SCR and observe the terminal configuration, Measure the breakdown voltage, latching and holding current. Plot V-I characteristics.
2	Perform experiment on triggering circuits for SCR. i.e. R triggering, R-C triggering and UJT triggering circuit.
3	Study and test AC voltage regulators using triac, anti parallel thyristors and triac&diac.
4	Study and obtain the waveforms for single-phase bridge converter.
5	Perform experiment on single phase PWM inverter.
6	Perform experiment on buck, boost and buck-boost regulators.
7	Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.
8	Control speed of a single-phase induction motor using single phase AC voltage regulator.
9	I. Study single-phase dualconverter. II. Study speed control of dc motor using single-phase dualconverter.
10	Study single-phase cyclo converter.
11	Perform experiment on Motor control – open loop & closed loop
12	Design, observe and perform experiment on various type of pulse generation from DSP/ FPGA Platform. Perform experiment for PWM inverters and choppers.