# Scheme of Teaching and Examination for M.Tech. Communication Systems

## I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14ELD11</td>
<td>Advanced Mathematics</td>
<td>4 Lecture 2 Practical/Field Work/Assignment/Tutorials 3</td>
<td>50 100 150</td>
<td>23</td>
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<tr>
<td>14ECS12</td>
<td>Antenna Theory and Design</td>
<td>4 Lecture 2 Practical/Field Work/Assignment/Tutorials 3</td>
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<td>14ECS13</td>
<td>Probability and Random Process</td>
<td>4 Lecture 2 Practical/Field Work/Assignment/Tutorials 3</td>
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<tr>
<td>14ECS14</td>
<td>Advanced Digital Communication</td>
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<td>14ECS15X</td>
<td>Elective - 1</td>
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<tr>
<td>14ECS16</td>
<td>DEC Lab -1</td>
<td>-- Practical/Field Work/Assignment/Tutorials 3</td>
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<tr>
<td>14ECS17</td>
<td>Seminar on Advanced topics from refereed journals</td>
<td>-- Practical/Field Work/Assignment/Tutorials 3</td>
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<td><strong>Total</strong></td>
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### Elective-1

- 14 ECS 151 Wireless and Mobile Networks
- 14 ECS 154 CMOS VLSI Design
- 14 ELD 152 Automotive electronics
- 14 ELD155 Simulation, Modeling, and Analysis
- 14 ELD153 Nanoelectronics
VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM  
SCHEME OF TEACHING AND EXAMINATION FOR  
M.Tech. Communication Systems

<table>
<thead>
<tr>
<th>II Semester</th>
<th>CREDIT BASED</th>
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<tr>
<td>Subject Code</td>
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<tr>
<td>14ECS21</td>
<td>Wireless Communication</td>
</tr>
<tr>
<td>14ECS22</td>
<td>RF and Microwave circuit design</td>
</tr>
<tr>
<td>14ECS23</td>
<td>Modern DSP</td>
</tr>
<tr>
<td>14ECS24</td>
<td>Optical Communication and Networking</td>
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<tr>
<td>14ECS25X</td>
<td>Elective-2</td>
</tr>
<tr>
<td>14ECS26</td>
<td>DEC Lab -2</td>
</tr>
<tr>
<td>14ECS27</td>
<td>Seminar on Advanced topics from refereed journals</td>
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<tr>
<td><strong>Project Phase-I(6 week Duration)</strong></td>
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<td><strong>Total</strong></td>
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Elective -2

<table>
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<th>Subject Code</th>
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<tbody>
<tr>
<td>14 ECS 251</td>
<td>Broadband Wireless networks</td>
</tr>
<tr>
<td>14 ECS 252</td>
<td>ASIC design</td>
</tr>
<tr>
<td>14 ECS 253</td>
<td>Advanced Embedded system</td>
</tr>
<tr>
<td>14 ECS 254</td>
<td>Multimedia Communication</td>
</tr>
<tr>
<td>14 ECS 255</td>
<td>Spread Spectrum Communication</td>
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</table>

** Between the II Semester and III Semester, after availing a vocation of 2 weeks.
### III Semester: INTERNSHIP #

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
<th>Teaching hours/week</th>
<th>Duration of the Exam in Hours</th>
<th>Marks for Total</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>14ECS31</td>
<td>Midterm Presentation on Internship (After 8 weeks from the date of commencement) *</td>
<td>Lecture: -</td>
<td>Practical / Field Work: -</td>
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<tr>
<td>14ECS32</td>
<td>Report on Internship (After 16 weeks from the date of commencement)</td>
<td>Lecture: -</td>
<td>Practical / Field Work: -</td>
<td>-</td>
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<tr>
<td>14ECS33</td>
<td>Evaluation and Viva-voce</td>
<td>Lecture: -</td>
<td>Practical / Field Work: -</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>Lecture: -</td>
<td>Practical / Field Work: -</td>
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</tbody>
</table>

* The student shall make a midterm presentation of the activities undertaken during the first 8 weeks of internship to a panel comprising Internship Guide, a senior faculty from the department and Head of the Department.

# The College shall facilitate and monitor the student internship program.

The internship report of each student shall be submitted to the University.
### IV Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
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<th>CREDITS</th>
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<tr>
<td></td>
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<td>Lecture</td>
<td>Practical / Field Work / Assignment/ Tutorials</td>
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<td>Exam</td>
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<td>14ECS41</td>
<td>Error control coding</td>
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<td>14ECS42X</td>
<td>Elective-3</td>
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<tr>
<td>14ECS43</td>
<td>Evaluation of Project Phase-I</td>
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<tr>
<td>14ECS44</td>
<td>Phase-II : Midterm evaluation of Project</td>
<td>-</td>
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<td>14ECS45</td>
<td>Evaluation of Project Work and Viva-voce</td>
<td>-</td>
<td>3</td>
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<td><strong>Total</strong></td>
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<td><strong>04</strong></td>
<td><strong>09</strong></td>
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</table>

**Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits**

### Elective -3:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
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<tbody>
<tr>
<td>14 ECS 421</td>
<td>RF MEMS</td>
</tr>
<tr>
<td>14 ECS 422</td>
<td>Advanced Computer Networks</td>
</tr>
<tr>
<td>14 ECS 423</td>
<td>Advances in VLSI Design</td>
</tr>
<tr>
<td>14 ECS 424</td>
<td>Communication System design using DSP algorithm</td>
</tr>
<tr>
<td>14 ECS 425</td>
<td>Advanced Radar systems</td>
</tr>
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</table>
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalize the topic of dissertation.

2) Project Phase – II: 16 weeks duration during III Semester. Evaluation shall be taken during the Second week of the IV Semester. Total Marks shall be 25.


Marks of Evaluation of Project:

- The I.A. Marks of Project Phase – I & II shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (Out of two external examiners at least one should be present).
Matrix Theory
QR EL Decomposition – Eigen values using shifted QR algorithm- Singular Value EL Decomposition - Pseudo inverse- Least square approximations

Calculus of Variations
Concept of Functionals- Euler’s equation – functional dependent on first and higher order derivatives – Functionals on several dependent variables – Iso perimetric problems- Variational problems with moving boundaries

Transform Methods
Laplace transform methods for one dimensional wave equation – Displacements in a string – Longitudinal vibration of a elastic bar – Fourier transform methods for one dimensional heat conduction problems in infinite and semi infinite rod.

Elliptic Equation
Laplace equation – Properties of harmonic functions – Fourier transform methods for laplace equations. Solution for Poisson equation by Fourier transforms method

Linear and Non Linear Programming
Simplex Algorithm- Two Phase and Big M techniques – Duality theory- Dual Simplex method. Non Linear Programming –Constrained extremal problems- Lagranges multiplier method- Kuhn- Tucker conditions and solutions
Reference Books:
Antenna Theory and Design

Subject Code : 14ECS12  IA Marks : 50
No. of Lecture Hours / Week : 04  Exam. Hours : 03
Total No. of Lecture Hours : 50  Exam. Marks : 100

Antenna fundamental and definitions: Radiation mechanism - overview, EM fundamentals, Solution of Maxwell's equations for radiation problems, Ideal dipole, Radiation patterns, Directivity and gain, Antenna impedance, Radiation efficiency, Antenna polarization.


Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non-uniformly excited equally spaced linear arrays, Mutual coupling, Multidimensional arrays, Phased arrays, Feeding techniques, Perspectives on Arrays.

Broadband antennas: Travelling wave antennas Helical antennas, Biconical antennas Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.

Aperture antennas: Techniques for evaluating gain, Reflector antennas - Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, FiECS representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.


Method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff’s networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics.

Computational EM: FTTD methods, Geometrical optics, Wedge diffraction theory, Ray fixed coordinate system, Uniform theory of wedge diffraction, E--plane analysis of horn antennas. Cylindrical parabolic antennas, Radiation by a slot on a finite ground plane, Radiation by a
monopole on a finite ground plane, Equivalent current concepts, Multiple diffraction formulation by a curved surfaces, Physical optics, Methods of stationary phase, physical theory of diffraction, Cylindrical parabolic reflector antennas.

**Reference books:**

Introduction to probability theory: Experiments, Sample space, Events, Axioms, Assigning probabilities, Joint and conditional, Baye's theorem, Independence, Discrete random variables, Engineering example

Random variables, Distributions, Density functions: CDF, PDF, Gaussian random variable, Uniform, Exponential, Laplace, Gamma, Erlang, Chi-square, Rayleigh, Rician and Cauchy types of random variables.

Operation on a single random variable: Expected value, EV of random variables, EV of functions of random variables, Central moments, Conditional expected values.

Characteristics functions: Probability generating functions, Moment generating function, Engineering applications, Scalar quantization, Entropy and source coding.

Pairs of random variables: Joint PDF, Joint probability mass functions, Conditional distribution, Density and mass functions, EV involving pairs of random variables, Independent random variables, Complex random variables, Engineering application.

Multiple random variables: Joint and conditional PMF, CDF, PDF, EV involving multiple random variables, Gaussian random variable in multiple dimension, Engineering application, Linear prediction.

Random process: Definition and characterisation, Mathematical tools for studying random processes, Stationery and Ergodic random processes, Properties of ACF.


Reference books:

## Advanced Digital Communication

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
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<tbody>
<tr>
<td>14ECS14</td>
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<table>
<thead>
<tr>
<th>No. of Lecture Hours / Week</th>
<th>Exam. Hours</th>
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<tbody>
<tr>
<td>04</td>
<td>03</td>
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</table>

<table>
<thead>
<tr>
<th>Total No. of Lecture Hours</th>
<th>Exam. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Digital modulation techniques: Digital modulation formats, Coherent binary modulation techniques, Coherent quadrature - modulation techniques, No-coherent binary modulation techniques, Comparison of binary and quaternary modulation techniques, M-ray modulation techniques, Power spectra, Bandwidth efficiency, M-array modulation formats viewed in the light of the channel capacity theorem, Effect of inter symbol interference, Bit verses symbol error probabilities, Synchronization, Applications.

Coding techniques: Convolutional encoding, Convolutional encoder representation, Formulation of the convolutional decoding problem, Properties of convolutional codes: Distance property of convolutional codes, Systematic and nonsystematic convolutional codes, Performance Bounds for Convolutional codes, Coding gain, Other convolutional decoding algorithms, Sequential decoding, Feedback decoding, Turbo codes.

Communication through band limited linear filter channels: Optimum receiver for channel with ISI and AWGN, Linear equalization, Decision - feedback equalization, Reduced complexity ML detectors, Iterative equalization and decoding - Turbo equalization.

Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive equalization of Trellis - coded signals, Recursive least square algorithms for adaptive equalization, Self recovering (blind) equalization.

Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems.

Digital communication through fading multipath channels: Characterization of fading multipath channels, The effect of signal characteristics on the choice of a channel model, Frequency nonselective, Slowly fading channel, Diversity techniques for fading multipath channels, Digital signals over a frequency selective, Slowly fading channel, Coded wave forms for fading channels, Multiple antenna systems.

**Reference books:**


Wireless and Mobile Networks

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>No. of Lecture Hours / Week</th>
<th>Exam. Hours</th>
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<td>14ECS151</td>
<td>: 50</td>
<td>: 04</td>
<td>: 03</td>
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Wireless LANs: Network components, design requirements, Architectures, IEEE-802.11x, WLAN protocols, 802.11p and applications.

WMANs, IEEE-802.16: Architectures, Components, WiMax mobility support, Protocols, Broadband networks and applications, WWANs, cellular networks, Satellite Network, Applications.


Reference books

Automotive fundamentals overview - Four stroke cycle, Engine control, Ignition system, Spark plug, Spark pulse generation, Ignition timing, Drive train, Transmission, Brakes steering system, Battery, Starting system.

Air/Fuel system - Fuel handling, Air intake system, Air/Fuel management.

Sensors: Oxygen (O2/EGO) sensors, Throttle position sensor (TPS), Engine crankshaft angular position (CKP) sensor, Magnetic reluctance position sensor, Engine speed sensor, Ignition timing sensor, Hall effect position sensor, ShiECSed fiECS sensor, Optical crankshaft position sensor, Manifold absolute pressure (MAP) sensor - Strain gauge and capacitor capsule, Engine coolant temperature (ECT) sensor, Intake air temperature (IAT) sensor, Knock sensor, Airflow rate sensor, Throttle angle sensor.


Exhaust after treatment systems: Air, Catalytic converter, Exhaust gas recirculation (EGR), Evaporative emission systems.

Electronic engine control: Engine parameters, Variables, Engine performance terms, Electronic fuel control systems, Electronic ignition controls, Idle speed control, EGR control.

Communication: Serial data, Communication systems, Protection, Body and chassis electrical systems, Remote keyless entry, GPS.

Vehicle motion control: Cruise control, Chassis, Power brakes, Antilock brake systems, (ABS), Electronic steering control, Power steering, Traction control, Electronically controlled suspension.

Automotive instrumentation: sampling, Measurement and signal conversion of various parameters.

Integrated body: Climate control systems, Electronic HVAC systems, Safety systems - SIR, Interior safety, lighting, Entertainment systems.

Automotive diagnostics: Timing light, Engine analyser, On-board diagnostics, off-board diagnostics, Expert systems.
Future automotive electronic systems: Alternative fuel engines, Collision avoidance radar warning systems, Low tire pressure warning system, Radio navigation, Advance driver information system.

Reference books

Introduction: Overview of nanoscience and engineering, Development milestones in microfabrications and electronic industry, Moore's Law and continued miniaturization, Classification of nanostructures, Electronics properties of atoms and solids: Isolated atom, bonding between atoms, Giant molecular solids, Free electron models, Energy bands, Crystalline solids, Periodicity of crystal lattices, Electronic conduction, Effects of nanometer length scale, Fabrication methods: Top-down processes, Bottom-up processes methods for templating the growth of the nanomaterials, Ordering nanosystem.

Characterization: Classification, Microscopic techniques, FiECS ion microscopy, Scanning probe techniques, Diffraction techniques: Bulk, Surface spectroscopy techniques: Photon, radio frequency, electron, surface analysis and depth profiling; Electron mass ion beam reflectometry, Techniques for property measurements: Mechanical, Electron, Magnetic, Thermal properties.

Inorganic Semiconductor nanostructures: Overview of semiconductor physics, quantum confinement in semiconductor, nanostructures: Quantum wells, Quantum wires, Quantum dots, Superlattices, Band offsets, Electronic density of states.

Fabrication techniques: Requirement of ideal semiconductors, Epitaxial growth of quantum wells, Lithography and etching, Cleaved edge overgrowth of vicinal substrates, strain induced dots and wires, Electrostatically induced dots and wires, quantum well width fluctuations, Thermally annealed quantum wells, Semiconductor nanocrystals, Colloidal quantum dots, Self assembly techniques.

Physical processes: Modulation doping, Quantum hall effect, Resonant tunnelling, Charging effects, Ballistic carrier transport, Interband absorption, Intraband absorption, Light emission processes, Phonon bottleneck, Quantum confined stark effect, Nonlinear effects, Coherence and dephasing, characterization of semiconductor nanostructures: Optical, Electrical and structural.

assembling nanostructure molecular materials and devices: Building block, Principles of self assembly, Methods to prepare and pattern nanoparticles, Templated nanostructures, Liquid crystal mesophases. Nanomagnetic materials and devices: Magnetism, materials, Magneto resistance, Nanomagnetism in technology, Challenges facing into nanomagnetism.

**Applications:** Injection Lasers: Quantum cascade lasers, Single photon sources. Biological tagging, Optical memories, Coulomb blockade devices, Photonic structures, QWIP’s, NEMS, and MEMS.

**Reference books:**

CMOS VLSI Design

<table>
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<th>: 14ECS154</th>
<th>IA Marks</th>
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<td>Exam. Hours</td>
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<tr>
<td>Total No. of Lecture Hours</td>
<td>: 50</td>
<td>Exam. Marks</td>
<td>: 100</td>
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MOS transistor theory: NMOS/PMOS transistor, Threshold voltage equation, Body effect, MOS device design equation, Sub threshold region, Channel length modulation, Mobility variations, tunnelling, Punch through, Hot electron effect MOS models, Small signal AC characteristic, CMOS inverters, An/Ap ratio, noise margin, Static load MOS inverters, Differential inverter, Transmission gate, Tristate inverter, BiCMOS inverter.

CMOS process Technology: Lambda based design rules, Scaling factor, Semiconductor technology overview, Basic CMOS technology, p-well/n-well/twin-well process. Current CMOS enhancement (oxide isolation, LDD, refractory gate, Multilayer interconnect), Circuit element, resistor, Capacitor, Interconnects, Sheet resistance and standard unit capacitance concept delay unit time, Inverter delays driving capacitive loads, Propagate delays, MOS mask layer, Stick diagram, design rules and layout, Symbolic diagrams, MOS feints, Scaling of MOS circuits.

Basic of Digital CMOS design: Combinational MOS logic circuits -Introduction, CMOS logic circuits with the a MOS load, CMOS logic circuits, Complex logic circuits, transmission gate, Sequential MOS logic circuits - Introduction, Behaviour of high stable elements, SR latch circuits, Clocked latch and flip-flop circuits, CMOS D-latch and triggered flip-flop, Dynamic logic circuits - Introduction, principles of pass transistor circuits, Voltage bootstrapping synchronous dynamic circuit techniques, Dynamic CMOS circuit techniques.

CMOS analog design: Introduction, Single amplifier, Differential amplifier, Current mirrors, Bandgap references, Basis of cross operational amplifier.

Dynamic CMOS and clocking: Introduction, Advantages of CMOS over NMOS, CMOS/SOS technology, CMOS/bulk technology, Latchup in bulk CMOS, Static CMOS design, Domino CMOS structure and design, Charge sharing, Clocking - Clock generation, Clock distribution, Clocked storage elements.
Reference books:


Simulation, Modelling, and Analysis

Subject Code : 14ELD155
No. of Lecture Hours / Week : 04
Total No. of Lecture Hours : 50
IA Marks : 50
Exam. Hours : 03
Exam. Marks : 100

Basic simulation modeling: Nature of simulation, System models, discrete event simulation, Single server simulation, Alternative approaches, Other types of simulation.

Building valid, credible and detailed simulation models: techniques for increasing model validity and credibility, comparing real world observations.

Selecting input probability distributions: Useful probability distributions, Assessing sample independence, Activity-I, II and III, Model of arrival process.

Random number generators: Linear congruential, Other kinds, Testing number generators, Random variate generation: Approaches, Continuous random variates, Discrete random variates, Correlated random variates.

Output data analysis: Statistical analysis for terminating simulation, Analysis for steady state parameters, Comparing alternative system configuration, Confidence interval, Variance reduction techniques, Arithmetic and control variates.

Reference books:
Experiments can be done using Hardware tools such as Spectrum analyzers, Signal sources, Power Supplies, Oscilloscopes, High frequency signal sources, fiber kits, Measurement benches, DSP processor kit, FPGA kit, Logic analyzers, PC setups, etc. Software tools based experiments can be done using, FEKO simulator, NS2 simulator, MATLAB, etc.

1. Matlab/C implementation of to obtain the radiation pattern of an antenna.
2. Experimental study of radiation pattern of different antennas.
3. Significance of pocklington's integral equation.
5. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
6. Analysis of E & H plane horns.
7. Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
8. Determination of the modes transit time, electronic timing range and sensitivity of klystron source.
9. Antenna resonance and gain bandwidth measurements.
10. Study of digital modulation techniques using CD4051 IC
11. Build a hardware pseudo-random signal source and determine statistics of the generated signal source..
13. Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency, and VSWR.

15. Determine the frequency response of BPSK, BFSK, and Binary ASK modulators using Spectrum analyzers.
Wireless Communication

Subject Code : 14ECS21  
IA Marks : 50
No. of Lecture Hours / Week : 04  
Exam. Hours : 03
Total No. of Lecture Hours : 50  
Exam. Marks : 100

Wireless channel: Physical modeling for wireless channels, I/O model of wireless channels, time and frequency response, Statistical models

Point-to-Point Communication: Detection in Rayleigh fading channels, Time diversity, Antenna diversity, Frequency diversity, Impact of the channel uncertainty.

Diversity: Introduction Micro-diversity, Micro-diversity and Simulcast combination of signals, Error probability in fading channels with diversity reception, Transmit diversity.

Capacity of wireless channel: AWGN channel capacity, Resources of AWGN channel, Linear time invariant Gaussian channel, Capacity of fading channels.

MIMO Systems: Introduction, Space diversity and system based on space diversity, Smart antenna systems and MIMO, MIMO based system architecture; MIMO exploits multipath, Space time processing, Antenna considerations for MIMO, MIMO channel modeling, MIMO channel measurements, MIMO channel capacity, CDD, Space time coding, advantages and applications of MIMO, MIMO application in 3G, MIMO-1, Spatial multiplexing channel modeling: Multiplexing capability of MIMO channels, Physical modeling of MIMO channels. Modeling MIMO fading channels,

Multi antenna systems, Smart antennas, Multiple Input and Multiple Output systems.

Reference books:
## RF and Microwave Circuit Design

<table>
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<th>: 14ECS22</th>
<th>IA Marks</th>
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<tr>
<td>Total No. of Lecture Hours</td>
<td>: 50</td>
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<td>: 100</td>
</tr>
</tbody>
</table>


Basic consideration in active networks and design of amplifiers, oscillators and detector: Stability consideration, gain consideration, Noise consideration. Linear and nonlinear design: Introduction, Types of amplifier, Design of different types of amplifiers, Multistage small signal amplifiers, Design of transistor oscillators, Detector losses, detector design.

Mixers Phase shifters and RF and Microwave IC design: Mixer types, Conversion loss for SSB mixers, One diode mixer, Phase shifters, Digital phase shifters, Semiconductor phase shifters, RF and microwave IC design, MICs, MIC materials, Types of MICs, Hybrid verses monolithic ICs, Chip materials.

**Reference books:**

Modern DSP

Introduction and Discrete Fourier transforms: Signals, Systems and processing, Classification of signals, The concept of frequency in continuous time and discrete time signals, Analog to digital and digital to analog conversion, Frequency-domain sampling. The discrete Fourier transform, Properties of the DFT, Linear filtering methods based on the DFT.

Design of digital filters: General considerations, design of FIR filters, Design of IIR filters from analog filters, Frequency transformations.

Multirate digital signal processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Sampling rate conversion of band pass signals, Sampling rate conversion by an arbitrary factor, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank.


Reference books:
Optical Communication and Networking

<table>
<thead>
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<th>Subject Code</th>
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<td>: 50</td>
<td>Exam. Marks</td>
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Introduction: Propagation of signals in optical fiber, Different losses, Nonlinear effects, Solutions, Optical sources, Detectors.
Optical components: Couplers, Isolators, Circulators, Multiplexers, Filters, Gratings, Interferometers, Amplifiers.
Modulation - Demodulation: Formats, Ideal receivers, Practical detection receivers, Optical preamplifiers, Noise considerations, Bit error rates, Coherent detection.
Optical Networks: Client layers of optical layer, SONET/SDH, Multiplexing, layers, Frame structure, ATM functions, Adaptation layers, Quality of Service (QoS) and flow control, ESCON, HIPPL.
WDM network elements: Optical line terminal, Optical line amplifiers, Optical cross connectors, WDM network design, Cost trade offs, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion, Statistical dimensioning model.
Control and management: Network management functions, management framework, Information model, management protocols, Layers within optical layer performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm management, Configuration management.

Reference books:
Broadband Wireless Networks

Frequency utilization and system profiles: Cellular concept, Licensed and unlicensed frequencies, Fixed WiMAX system profiles, Mobile WiMAX profiles.
WiMAX physical layer: OFDM transmission, SOFDMA, subcarrier permutation, 802.16 transmission chains, Channel coding, Turbo coding, Burst profile.
WiMAX MAC and QoS: CS layer, MAC function and frames, Multiple access and burst profile, Uplink bandwidth allocation and request mechanisms, Network entry and QoS management.
Radio engineering considerations: Radio resource management, Advance antenna technology in WiMAX, MBS. WiMAX architecture, Mobility handover and power save modes, Security.

Reference books:
Introduction: Full custom with ASICs, Semicustom ASICs, Standard cell based ASIC, Gate array based ASIC, Channelled gate array, Channel less gate array, structured gate array, Programmable logic device, FPGA design flow, ASIC cell libraries.

Data logic cells: Datapath elements: Adders, Multipliers, Arithmetic operator, I/O cell, Cell compilers.

ASIC Library design: Logical effort: Practicing delay, Logical area and logical efficiency, Logical paths, Multi stage cells, optimum delay, Optimum number of stages, Library cell design.

Low-level design entry: Schematic entry: Hierarchical design, The cell library, Names, Schematic, Icons and symbols, Nets, Schematic entry for ASICs, Connections, Vectored instances and buses, Edit in place attributes, Netlist, Screener, back annotation.

Programmable ASIC: Programmable ASIC logic cell, ASIC I/O cell.

A brief introduction to low level design Language: An Introduction to EDIF, PLA tools, An introduction to CFI designs representation, Half gate ASIC, Introduction to synthesis and simulation.

ASIC construction, floor planning and placement and routing: Physical design, CAD tools, System partitioning, Estimating ASIC size, Partitioning methods, Floor planning tools, I/O and power planning, Clocking planning, Placement algorithms, Iterative placement improvement, Ti driven placement methods, Physical design flow global routing, Logical routing, Detailed routing, Special routing, Circuit extraction and DRC.

Reference books:
Typical embedded system: Core of the embedded system, Memory, Sensors and Actuators, Commutation interface, Embedded firmware, Other system components.

Characteristics and quality attribution of Embedded Systems.

Hardware software co-design and program modelling: Fundamental issues in hardware software co-design, Computational models in embedded design, Introduction to Unified modelling language, Hardware software trade-off.

Embedded firmware design and development: Embedded firmware design approaches, Embedded firmware development language.

Real time operating system (RTOS) based embedded system design: Operating system basics, Types of OS, Tasks, Process and threads, Multiprocessing and multitasking, Task scheduling, Threads, Processing and scheduling: Putting them altogether, Task communication, task synchronization, Device drivers, How to choose an RTOS.

The embedded system development environment: The Integrated development environment (IDE), Types of files generated on cross compilation, Disassembler/Decompilers, Emulators and debugging, Target hardware debugging, Boundary scan.


**Reference books:**

Multimedia communication

Subject Code: 14ECS254
No. of Lecture Hours / Week: 04
Total No. of Lecture Hours: 50
IA Marks: 50
Exam. Hours: 03
Exam. Marks: 100

Multimedia Communications: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS. (Ref.1 Chap. 1)

Information Representation: text, images, audio and video, Text and image compression, compression principles, text compression, image compression. Audio and video compression, audio compression, video compression, video compression principles, video compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video.(Ref 1 Chap 3 &4)

Detailed Study of MPEG 4: coding of audiovisual objects, MPEG 4 systems, MPEG 4 audio and video, profiles and levels. MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework, Significant features of JPEG 2000, MPEG 4 transport across the Internet. (Ref2. Chap.5)

Synchronization: Notion of synchronization, presentation requirements, reference model for synchronization, Synchronization specification. Multimedia operating systems, Resource management, process management techniques. (Ref. 3. Chap 9 & 11)

Multimedia Communication Across Networks: Layered video coding, error resilient video coding techniques, multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, multimedia in mobile networks, multimedia in broadcast networks. (Ref.2 Chap. 6)

Assignments / Practicals can be given on writing the programs to encode and decode the various kinds of data by using the algorithms. Students can collect several papers from journals/conferences/Internet on a specific area of multimedia communications and write a review paper and make a presentation.

Reference Books:

Spread Spectrum Communication

Subject Code : 14ECS255
No. of Lecture Hours /week : 04
Total no. of Lecture Hours : 50
IA Marks : 50
Exam Hours : 03
Exam Marks : 100

Review of digital communication concepts, direct sequence and frequency hop spread spectrum systems.
Hybrid direct sequence/frequency hop spread spectrum. Complex envelop representation of spread spectrum signals.
Spread spectrum communication system model, Performance of spread spectrum signals in jamming environments, Performance of spread spectrum communication systems with and without forward error correction.
Diversity reception in fading channels, Cellular radio concept, CDMA cellular systems. Examples of CDMA cellular systems. Multicarrier CDMA systems. CDMA standards

Reference Books:
List of laboratory Experiments - Modern digital signal processing using MATLAB

1. Question based on response of LTI systems to different inputs. A LTI system is defined by the difference equation \( y[n] = x[n] + x[n+1] + x[n+2] \).
   (a) Determine the impulse response of the system and sketch it.
   (b) Determine the output \( y[n] \) of the system when the input is \( x[n] = u[n] \).
   (c) Determine the output of the system when the input is a complex exponential (E.g. \( x[n] = 2\exp(j0.26n) \)).

2. Question on design of simple digital filter using the relationship between pole and zeros and the frequency response of the system.
   Design a simple digital FIR filter with real coefficient to remove a narrowband i.e., sinusoidal) disturbance with frequency \( f_0 = 50 \text{Hz} \). Let \( f_s = 300 \text{Hz} \) be the sampling frequency.
   (a) Determine the desired zeros and poles of the filter.
   (b) Determine the filter coefficients with the gain \( K = 1 \).
   (c) Sketch the magnitude of the frequency response.

3. Question on simple digital filtering using the relationship between pole and zeros and the frequency response of the system.
   Design an IIR filter with real coefficient with same specifications mentioned in Q2 and repeat the steps (a) to (c).

4. Question to understand the effect of time domain windowing
   Generate a signal with two frequencies \( x(t) = 3 \cos(2\pi f_1 t) + 2 \cos(2\pi f_2 t) \) sampled at \( f_s = 8 \text{kHz} \). Let \( f_1 = 1 \text{kHz} \) and \( f_2 = f_1 + A^\prime \) and the overall data length be \( N = 256 \text{points} \).
   (a) From theory, determine the minimum value of \(^A^\prime\) necessary to distinguish between the two frequencies.
(b) Verify this result experimentally, using the rectangular window, look at the DFT with several values of 'A' so that you verify the resolution.

(c) Repeat part (b) using a hamming window. How did the resolution change?

5. Comparison of DFT and DCT (in terms of energy compactness)

Generate the sequence x[n]=n-64 for n=0, ...127.

(a) Let X[k] = DFT{ x[n] }. For various values of l, set to zero "high frequency coefficients" X[64-l]= ...X[64]= ......X[64+L]=0 and take the inverse DFT. Plot the results.

(b) Let XDCT[k]=DCT(X[n]). For the same values of L, set to zero "high frequency coefficient" XDCT [127-L]= ....XDCT[127]. Take the inverse DCT for each case and compare the reconstruction with the previous case.

6. Filter design:

design a discrete low pass filter with the specification given below:

Sampling frequency =2kHz
Passband edge = 260Hz.
Stop band edge = 340Hz
Max. pass band attenuation=0.1dB.
minimum stop band attenuation = 30dB.

Use the following design methodologies:
Hamming windowing
Kaiser windowing,

Applying bilinear transformation to a suitable Butterworth filter. Compare the obtained filters in terms of performance (accuracy in meeting specifications) and computational complexity).

**List of experiments to be done using the DSP processor**

1. Write an ALP to obtain the response of a system using linear convolution whose input and impulse response are specified.
2. Write an ALP to obtain the impulse response of the given system, given the difference equation.
3. Design of equiripple filters.
4. Applications of frequency transformation in filter design.
5. Computation of FFT when N is not a power of 2.
6. Sampling rate conversion and plot of spectrum.
7. Analysis of signals by STFT and WT
8. Delayed auditory feedback signal using 6713 processor.
9. Record of machinery noise like fan or blower or diesel generator and obtaining its spectrum.
Introduction to algebra: Groups, fiECSs, binary fiECS arithmetic, Construction of Galois fiECS GF (2m) and its properties, Computation using Galois filed GF (2m) arithmetic, Vector spaces and Matrices.

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, decoding circuits, Hamming codes, Reed-Muller codes. Golay codes, Product codes and interleaved codes.

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding using multiplication circuits, Systematic cyclic codes - Encoding using feedback shift register circuits, generator matrix for cyclic code, Syndrome computing and error detection, Meggitt decoder, Error trapping decoding, Cyclic hamming codes, Golay code, Shortened cyclic codes.

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois fiECS arithmetic, Implementation of error correction. Non-binary BCH codes: q-ary linear block codes, Primitive BCH codes over GF(q), Reed -Solomon codes, decoding of non-binary BCH and RS codes: The Berlekamp - Massey Algorithm.

Majority Logic decodable codes: One -step majority logic decoding, One-step majority logic decodable codes, Two-step majority logic decoding, Multiple-step majority logic decoding.

Convolution codes: Encoding of convolutional codes, Structural properties, Distance properties, Viterbi decoding algorithm for decoding, Soft output Viterbi algorithm, Stack and Fano sequential decoding algorithms, Majority logic decoding.

Concatenated codes and Turbo codes: Single level concatenated codes, Multilevel concatenated codes, Soft decision multistage decoding, Concatenated coding schemes with convolutional inner codes, Introduction to Turbo coding and their distance properties, design of Turbo codes.

Burst - error - Correcting codes: Burst and random error correcting codes, Concept of interleaving, Cyclic codes for burst error correction - Fire codes, Convolutional codes for burst error correction
Reference books:

**RF MEMS**

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Review: Introduction to MEMS: Fabrication for MEMS transducers and actuators, Microsensing for MEMS, Materials for MEMS.

MEMES materials and fabrication techniques: Metals, Semiconductors, Thin films, Materials for polymer MEMS, Bulk machining for Silicon based MEMS, Surface machining for Silicon based MEMS, Micro stereo-lithography for polymer MEMS.

RF MEMS Switches and micro-relays: Switch parameters, Basics of switching, Switches for RF and Microwave applications, Actuation mechanisms, Micro-relays and micro-actuators, Dynamic of switch operations, MEMS switch design and design consideration, MEMS inductors and capacitors.


Micromachined transmission line and components: Micromachined transmission line: Losses in transmission line, coplanar lines, MicroshiECS and membrane supported lines, MicroshiECS components, Micromachined waveguides, Directional couplers and Mixers, Resonators and Filters.

Micromachined antennas: design, Fabrication and measurements, Integration and packaging for RF MEMS, Roles and types of packages, Flipchip techniques, Multichip module packaging and Wafer bonding, Reliability issues and thermal issues.

**Reference books:**

Advanced Computer Networks

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Multiple access: Multiplexing - FDM, TDM, SM.

Local Area networks: Ethernet, Token ring, FDDI, Switching - Circuit switching, Packet switching, Multicasting.

Scheduling: Performance bounds, Best effort disciplines, Naming and addressing, Protocol stack, SONET, SDH.

ATM Networks: AAL, Virtual circuits, SSCOP, Internet - Addressing, Routing, Endpoint control.

Internet Protocol: IP, TCP, UDP, ICMP, HTTP.

Traffic management: Models, Classes, Scheduling.

Control of Networks: QoS, Static and dynamic routing, Markov chains, Queuing models, Bellman Ford and Dijkstra's algorithm, Window and rate congestion control, Large deviations of a queue and network, Open and closed loop flow control, Control of ATM networks.

Reference books:

Advances in VLSI Design

Subject Code : 14ECS423
No. of Lecture Hours / Week : 04
Total No. of Lecture Hours : 50
IA Marks : 50
Exam. Hours : 03
Exam. Marks : 100

Review of MOS circuits: MOS and CMOS static plots, Switches, Comparison between CMOS and BiCMOS.
MESFETs: MESFET and MODFET operations, Quantitative description of MESFETs.
MIS structure and MOSFETS: MIS systems in equilibrium, Under bias, Small signal operation of MESFETs and MOSFETs.
Short channel effects and challenges to CMOS: Short channel effects, Scaling theory, Processing challenges to further CMOS miniaturization.
Beyond CMOS: Evolutionary advances beyond CMOS, Carbon nano-tubes, Conventional v/s tactile computing, Computing, Molecular and biological computing Mole-electronics - Molecular Diode and diode-diode logic. Defect tolerant computing.
Special Circuit Layout and Technology mapping: Introduction, Talley circuits, NAND-NAND, NOR-NOR, AOI logic, NMOS, CMOS multiplexers, Barrel shifters, Wire routing and module layout.
System design: CMOS design methods, Structured design methods, Strategies encompassing hierarchy, Regularity, Modularity and Locality, CMOS chip design options, Programmable logic, Programmable inter connect, Programmable structure, Gate arrays, Standard cell approach, Full custom design.

Reference books:
Communication System design using DSP algorithm

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Introduction to the course: Digital filters, Discrete time convolution and frequency responses, FIR filters - Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. IIR filters - realization and implementation, FFT and power spectrum estimation: DTFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum.

Analog modulation scheme: Amplitude Modulation - Theory, generation and demodulation of AM, Spectrum of AM signal. Envelope detection and square law detection. Hilbert transform and complex envelope, DSP implementation of amplitude modulation and demodulation.


SSB: Theory, SSB modulators, Coherent demodulator, Frequency translation, Implementation using DSP hardware.


PAM and QAM: PAM theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM.

QAM fundamentals: Basic QAM transmitter, 2 constellation examples, QAM structures using passband shaping filters, Ideal QAM demodulation, QAM experiment. QAM receivers-Clock recovery and other frontend sub-systems. Equalizers and carrier recovery systems.
Experiment for QAM receiver frontend. Adaptive equalizer, Phase splitting, Fractionally spaced equalizer. Decision directed carrier tracking, Blind equalization, Complex cross coupled equalizer and carrier tracking experiment.

Echo cancellation for full duplex modems: Multicarrier modulation, ADSL architecture, Components of simplified ADSL transmitter, A simplified ADSL receiver, Implementing simple ADSL Transmitter and Receiver.

**Reference Books:**

Advanced Radar Systems

Introduction: Range equation, Transmitter and Receiver parameters, and Model, Types of Radars.
Radar antenna: Reflector types, Sidelobe control, Arrays - Array factor and beamwidth, Synthetic aperture, adaptive antennas.
Propagation effects: Multipath, Low altitude, Ionosphere.
Radar Networks: Matched filter response and noise consideration.
Data Processing: FFT, Digital MTI, Tracking, Plot track.
Applications: Secondary surveillance, Multistatic, Over the Horizon, Remote sensing and Meteorological radars.

Reference Book:
1. Meril I. Skolnik, "Radar handbook".
2. M. J. B. Scanlan, "Modern Radar Techniques".