Pre Ph.D./ M.Phil.
Electronics
Paper I : Research Methodology and Computer Applications

Section I

UNIT 1 : Research Methodology : An Introduction
Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.
Defining the Research Problem :
What is a Research Problem? Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration, Conclusion.
Research Design :

UNIT 2 : Methods of Data Collection :
Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.
Testing of Hypotheses (Parametric or Standard Tests of Hypotheses) :

Section II

UNIT 3 : OST overview:
Evolution & development of OST and contemporary technologies, Factors leading to its growth. Open Source Initiative (OSI), Free Software Foundation and the GNU
Project, principle and methodologies. Contexts of OST (India & international). Applications of open source

Introduction to SCILAB, Explaining the SCILAB GUI (Graphical User Interface), Usage of SCILAB Help/ docs/ basics, Variables and constants , Functions (Built in), Introduction to Matrices, Scripts and functions, Conditional statements and loops, Debugging , Basics of plotting in SCILAB, Linear equations and Numerical integration

UNIT 4 : Case Studies
SCILAB,
- Case study 1 : Design of PID – Fuzzy control system
- Case study 2 : Pseudo Random Noise/ White noise generator
- Case study 3 : Design of Digital filter
- Case study 4 : Neural control Design

NS2 Simulator : basic concepts
- Case study 1 : AdHoc Network realization
- Case study 2 : Network performance study

PSPICE : basic concepts
- Case study 1 : Buck, Boost and Buck-boost regulator design
- Case study 2 : R.F. Amplifier Design
- Case study 3 : Frequency Multiplier (Doubler, Tripler)

Xilinx Webpack :
- Case Study 1 : Multiplexer as Universal building block
- Case study 2 : Intelligent ALU design

Reference Books

2. SPICE for Circuits and Electronics Using PSPICE (2nd Edition) [Muhammad H. Rashid, PHI
5. Online documentation of SciLab, NS2, PSPICE, and XIlinx
Pre Ph.D./ M.Phil.
Electronics
Paper II : Recent Trends in Electronics

Unit 1: Digital system and VLSI design
EDA from methodologies to algorithms, Tools for integrated circuits and systems, Categories of
EDA tools, Challenge and Opportunities in EDA paradigm, Designing SoC using soft IP cores,
Types of IP cores, Design issues pertaining to Soft IP Cores, FPGA as a prototyping platform,
Different flavors of languages in EDA.
SoC Term and Scope, Constitutes of generic SoC, Processor Cores, Buses, on chip memory,
timing reference, ASIC Vs FPGA comparison in context with SoC, Full Custom Design,
Standard cell based design, Semicustom ASIC, Structured ASIC.
Case studies: Development of Network on Chip, ECG Logger, Multifunction Interface based on
FPGA, FPGA based high resolution A to D Converter.

Unit 2: Embedded System Design
Microprocessor and Microcontroller Architecture, Peripherals, Power modes, Embedded
Communication Protocols, Programming Languages and tools, Real Time Operating System.

Unit 3: Satellite and Optical Communications
Satellite Navigation and Global Positioning System, Optical fiber link design

Unit 4: Power Electronics and Systems
Phase Controlled Rectifiers firing circuits, triggering circuits., DC-DC, switch mode converters,
step down (Buck) converter, step-up (Boost) converter, Buck-Boost converter, Cuk-dc-dc
converter full bridge dc to dc converter. Cycloconverters Dual converters, microprocessor
based firing schemes for dual converter. Inverters and uninterruptible power supplies. DC
motor Drives and Induction Motor Drives

Unit 5: Wireless Systems
Speech Coding, Wireless Networking

Unit 6: Soft Computing
Introduction to Soft Computing, Synergism of Genetic Algorithms and Fuzzy Systems,
GA-Fuzzy System Approach and its applications, , Integration of Neural Networks and
Fuzzy Systems, Adaptive Neuro-Fuzzy Inference Systems, Constraints of ANFIS, Neuro-
Fuzzy Approach of Modeling, ANN-GA-Fuzzy Synergism and its applications, Training
of ANN, ANN Learning using GA.

Reference Books
Unit 1:
2. Harnessing VLSI System Design with EDA Tools, R.K. Kamat, S.A. Shinde, P.K. Gaikwad and
   Hansraj Guhilot, Springer, 2013
   Shelake, Springer 2012
Unit 2 :
2. Sloss, Symes, Wright, "ARM system developers guide" Morgan Kaufman, Elsevier, publication
3. Steve Furber, ARM System-on-chip Architecture, Addison Wesley
5. Myke Predko, Programming & Customizing PICmicro Microcontrollers, TMH.
8. Jean J. Labrosse, MicroC OS II: The Real Time Kernel, Publisher: CMP Books
9. Microcontroller datasheets for I2C, SPI, CAN and USB specifications and configuration

Unit 3: Satellite and Optical Communications
2. Harold Colimbiris, Fiber Optics Communication, Pearson 2010

Unit 4: Power Electronics and Systems
1. Power Electronics, P. C. Sen, Tata McGraw-Hill Education
4. Electrical Drives Concept and Applications, Vedam Subramanyam, Tata McGraw-Hill Education

Unit 5: Wireless Systems

Unit 6: Soft Computing
Pre Ph.D./M.Phil.
Electronics
Paper III: Digital Image Processing

Unit I:
Image representation, Resolution, Image Formats, Colour Spaces, Reading/writing images in Matlab, Image formation, Mathematical representation, Image capture, digitization, noise, Pixels, operations on pixels, histograms Image Enhancement, Filters, Filtering for noise removal, filtering for edge detection, Fourier transforms and frequency-domain processing - Frequency space, Calculation of the Fourier spectrum, 1-D/2-D Fourier transform, frequency-space filtering, convolution theorem, optical transfer function, digital Fourier transforms

Unit II:

Geometry - description of shape, Shape-preserving transformations, Shape transformation, Affine transformation in homogeneous coordinates, procrustes transformation, projective transform, Nonlinear transformations, Warping, Overdetermined spatial transformations

Unit III:
Morphological processing - Binary images, Structuring elements and neighbourhoods, Dilation and erosion, Structuring element decomposition, Morphological opening and closing, Boundary extraction, Extracting connected components, Region filling, hit-or-miss transformation, ‘don’t care’ pixels, Skeletonization, Opening by reconstruction, grey-scale morphology, top-hat transformation

Image features - Landmarks and shape vectors, Single-parameter shape descriptors, Signatures and the radial fourier expansion, Statistical moments as region descriptors, Texture features based on statistical measures, Principal component analysis, Dimensionality reduction,

Unit IV:
Image segmentation – Use of Image properties and features in segmentation, Intensity thresholding, Region growing and region splitting, Split-and-merge algorithm, edge detection, the laplacian of Gaussian and difference of Gaussians filters, Interest operators, Watershed segmentation, Image segmentation with markov random fields
Classification - Purpose, Supervised and unsupervised classification, Design of classification systems, Simple classifiers: prototypes and minimum distance criteria, Linear discriminant functions, Bayesian classification, Ensemble classifiers, Unsupervised learning

References Books

1. **Antenna Parameter Measurement** [15]
   Introduction, directional pattern, gain, absolute method, comparison method, celestial radio sources, radar techniques, phase, direct method, reference antenna method, deferential method, polarization, impedance, efficiency, directivity/gain method, radiometric method, random field method, wheeler cap method, other measurement method for small antennas, current distribution, vector network analyzer, field strength meter.

2. **Antenna Measurement Ranges** [15]
   Introduction, Basic Concept, reciprocity in antenna measurement, Near-field, far-field, Co-ordinate system, measurement ranges, elevated ranges, ground reflection ranges, anechoic chambers and absorbing materials, compact antenna test ranges, near field ranges, testing of ranges, instrumentation, transmitter and receiver, data processing. Typical sources error in antenna measurement, phase error and amplitude taper, reflections, other sources of error.

3. **Antennas for Satellite communication** [15]
   The earth segment, receive only home TV system, the outdoor unit, the indoor unit for analog(FM) TV, master antenna TV system, DTH TV System, transit-receive Earth station. Transmission losses, free space transmission, Feeder losses, antenna misalignment losses, antenna noise, Amplification noise temperature, System noise, effect of rain. Satellite dish antenna, Antenna design considerations for satellite communication, example on parabolic dish design.

4. **Microstrip patch antenna** [15]
   Basic characteristics, feeding methods, methods of analysis, Rectangular patch, circular patch, quality factor, bandwidth and frequency, input impedance, Fractal antenna introduction and geometry, Fractal patch antenna design, Koch loop method, Sierpinski loop method.

**Reference Books**

2. Antenna and Wave propagation G.S.N. Raju Pearson Publication Fifth Impression-2011
Unit 1: Overview of Wireless Sensor Networks

Unit 2: Architectures
Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway concepts.

Unit 3: Networking

Unit 4: Sensor Network Platforms
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming, Tiny OS, Mate, Magnet OS.

Reference Books
Paper III

Biomedical Engineering

Unit 1:

Unit 2:
Electrodes, Basic Instrumentation, Electrocardiograph, Electroencephalograph, Electromyograph, Phonocardiograph,

Unit 3:
Transducers, Blood Pressure, Blood Flow and Pulse Oximeters, Heart Rate, Respiration Rate and Temperature Meters, Fetal Monitor, Audiometer and Hearing Aid, X-Ray Physics, Fluoroscopy and Radiography-Ray Tubes, X-Ray Equipment.

Unit 4:
Ultrasonic Scanner, Computed Tomography (CT-SCAN), Magnetic Resonance Imaging (MRI), Endoscope and Electron Microscope, Thermograph and Nuclear Imaging, Electric Shock, Electric Shock Hazards in Hospital Environment, Examples of Shock Hazards Safety Education and Precaution

References:
1. “Medical Electronics by A.G.Patil”.
5. “Biomedical Measurement” by Glenn R.Blackwell, PE, Biomedical Instrumentation &Technology
Paper III

Modern communication System

Unit-1: Antenna Parameter Measurement [15]

Unit-2: Antenna Measurement Ranges [15]
Introduction, Basic Concept, reciprocity in antenna measurement, Near-field, far-field, Co-ordinate system, measurement ranges, elevated ranges, ground reflection ranges, anechoic chambers and absorbing materials, compact antenna test ranges, near field ranges, testing of ranges, instrumentation, transmitter and receiver, data processing. Typical sources error in antenna measurement, phase error and amplitude taper, reflections, other sources of error

Unit-3: Satellite communication [15]
The earth segment, receive only home TV system, the outdoor unit, the indoor unit for analog(FM) TV, master antenna TV system, DTH TV System, transit-receive Earth station, Transmission losses, free space transmission, Feeder losses, antenna misalignment losses, antenna noise, Amplification noise temperature, System noise, effect of rain, Satellite dish antenna, Antenna design considerations for satellite communication, example on parabolic dish design.

Unit-4: Antenna positioning System and Algorithms [15]
Pointing error sources, models, control algorithms, command preprocessor, AZ track imperfection, conscan, (Ref. Wodek Gawronski, ”Control and Pointing Challenges of the NASA deep space Network antennas,” 8th IEEE International Conference on methods and model in automation and robotics szczcin, Poland, Sept 2002.)
Antenna under test (Control engineer point of view), performance criteria and design goals, PI controller, LQG controller, $H\infty$ controller, Hardware restriction.
(Ref. Wodek Gawronski, ”Antenna Control System: From PI to $H\infty$,” IEEE antennas and Propagation Vol. 43, No. 1, 2001)
Open loop model, PI controller and rigid antenna, LQG controller and flexible antenna, Properties of LQG weight, limits of LQG weight, LQG controller tuning procedure.
Mechanical drives, gear drives, classification of gears, selection of types of gears, law of gearing, standard system of gear teeth, backlash, number of teeth face width

References
2. Antenna and Wave propagation G.S.N. Raju Pearson Publication Fifth Impression-2011
5. Wodek Gawronski, “Control and Pointing Chanllenges of NASA deep space network antennas”, 8th IEEE international conference on methods and model in automation and robotics szczcin, Poland, sept 2002
UNIT 1: Power Semiconductor devices
Ideal switch, diode, transistor, power MOSFET, IGBT, Diac, MCT MOSFET, Snubber circuit, power factor and convertor
DC-DC line regulation – line regulator topology, parameter of line regulator, Analysis of regulators, Basic DC-DC convertor (Boost, BUCK, Buck-Boost) practical issues.

UNIT 2: DC-AC switch mode convertor
Inverter topology, self-driven inverter, quassi-square wave inverter, three phase inverter and PWM inverter.
Design of magnetics
Dissipative components flux and flux density, potential transformer, current transformer, etc.
Modeling of system – I/O relations, transfer function, block diagram, bode graphs and space vector modeling.

UNIT 3: Control system essentials
Representation of system in digital domain, Z-transform, digital filter, mapping between S-plane and Z- plane, effect of sampling, control system basics, state space method.
Digital controller design – control design technique, bode diagram method, PID controller, root locus method, state space method, full state feedback, tracker controller design, IM control with o/p feedback, optimal and robust controller design

UNIT 4: Discrete computation essentials
Number formulas, normalization, Arithmetic operations. Thermal aspects, reliability modeling and predictions.

References
2. Power Electronics: Circuits, Devices And Applications, M.H.Rashid, Pearson Education India, 01-Sep-2003
Paper III

Advances in Embedded Systems and VLSI Design

Unit-1: State of Art Techniques in Embedded System Design (15)
Latest design techniques in Embedded systems, hardware/software codesign, Embedded micro controller cores, embedded memories, Examples of embedded systems, sensors and interfacing techniques, Real-time concepts, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, best effort current best practice in scheduling (e.g. Rate Monotonic vs. static schedules), Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems - RT Linux, VRTX.

Unit-2: Programming Aspect of Embedded Systems (15)
Programming languages for embedded systems e.g., Handel-C and Esterel, system support for embedded systems, selected embedded system-based applications: process-control, robotics, etc. Software Development Methodology: Model based development, Statecharts, etc. Case studies, Controlling an Injection molding process, Flight simulator, digital call center handler, codec.

Unit-3: Latest Techniques in VLSI Design (15)
Introduction to hierarchical structural design. Role of CAD in VLSI design process. Techniques and algorithms for symbolic layout and routing. CMOS processing technology, CMOS building blocks and other approaches for reusing digital soft IP cores

Unit-4: Advances in VLSI System Design (15)
Use of pipelining and parallelism, self-synchronized designs, VLSI computing structures. Introduction to systolic arrays, mapping algorithms on systolic arrays, design of systolic arrays, system examples and design exercises.

References:
Paper III
Problem Solving With Soft Computing

Unit-1: Pulsed Neuron Models: The New Generation

Unit-2: Fuzzy Sets, Fuzzy Systems and Application
Need For Numeric And Linguistic Processing, Fuzzy Uncertainty And The Linguistic Variable, Membership Function, Geometry Of Fuzzy Sets, Simple Operation Of Fuzzy Sets, Fuzzy Rules For Approximate Reasoning, Rule Composition And Defuzification.

Unit-3: Genetic Algorithm

Unit 4: Neural Networks and the Soft Computing Paradigm

Reference Books