Adikavi Sri Maharshi Valmiki University, Raichur

Department of Instrumentation Technology

Ph.D. Entrance Syllabus
For
Electronics and Instrumentation

With effect from the academic year 2025-26 and onwards

SYLLABUS FOR Ph.D. ENTRANCE TEST

SUBJECT: ELECTRONICS AND INSTRUMENTATION

FROM THE ACADEMIC YEAR 2025-26

PART-A
Research Methodology

Unit1: Introduction to Research:

Nature and importance of research - Aims, Objectives and Principles, Fundamental research vs. applied research with examples, Qualitative vs Quantitative research with examples, Theoretical research vs. experimental research with examples.

Selection of a research problem and Sources of literature – Journals, Conferences, Books. Types of sources: Literature Survey Engines - Scopus, Web of Science, Google Scholar, PubMed, NCBI, Scihub, etc. How to read a research paper?, Science citation index: Citations, h-index, i10 index, impact factor

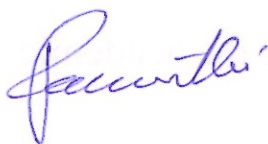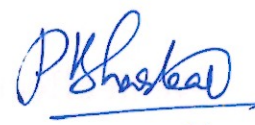### Unit2: Methods of Data Collection:

Data Collection Methods - Framing a hypothesis, designing controlled experiments, choosing the sample-size, sampling bias, importance of independent replicates, conducting an experiment, maintaining a lab notebook to record observations, Identifying experimental errors.

Case studies on well-designed experiments vs. poorly designed experiments. Correlations vs. Causation, Good laboratory Practices.

Unit3: Data analysis (Practical):

Data Presentation and Writing: Technical presentation, technical writing, Formatting citations; MS Excel/ origin for plotting the data (pie chart, plots, bar charts)

Analysis using software tools: Descriptive Statistics: Mean, standard deviation, variance, plotting data and understanding error-bars. Curve Fitting: Correlation and Regression. Distributions: Normal Distribution, Gaussian distribution, skewed distributions, Inferential Statistics: Hypothesis testing and understanding p-value, Parametric tests: Student's t-test, ANOVA, Tests to analyze categorical data: Chi-square test.

PART-B
Core Subject

UNIT I: ANALOG AND DIGITAL ELECTRONICS

Analysis of Operational Amplifiers: Characteristics, configurations, Mathematical operations. Op-amp applications. Number systems and codes, Logic gates and Boolean algebra, Combinational logic circuits, Flip-flops, Digital arithmetic operations, Karnaugh Maps, Counters and shift registers.

UNIT II: FUNDAMENTALS OF INSTRUMENTATION

Instruments and their classification, Static Characteristics of Instrument, Types of Transducers/ Sensors, Signal Conditioners: Amplifiers, filters, Peak detector, Sample and hold circuit, Phase sensitive detector, A/D and D/A converters. Recorders: X-Y recorders, Galvanometric recorder, Servo type of potentiometric recorder, Magnetic tape recorder, Digital recorders of memory type

UNIT III: CONTROL SYSTEM

Control System: Open-loop and Closed-loop, Feedback and its effects, Mathematical Modeling, Transfer function Approach to Physical System, Block Diagram Algebra, Signal flow-graphs. Time Response Analysis, Stability Criterion and Root Locus Techniques. Frequency Response Analysis and Stability Criteria, Polar plots, Bode Plots, Nyquist stability criterion, Concept of state variables and state models.

UNIT IV: 8051 MICROCONTROLLER AND APPLICATIONS

8051 Microcontroller Architecture, addressing modes, instructions set, programming, Interfacing of Peripherals: memory (RAM & EPROM), 8155, 8755, A/D & D/A converters. Interfacing of seven segment display, Multiplexed display, LCD module, and Stepper motor. 8051 for measurement of frequency and time period of TTL signal, Temperature control system, DC motor speed control.

UNIT V: VLSI DESIGN

Metal-Oxide Semiconductor (MOS) and related VLSI Technology. Electrical Properties of MOS and BiCMOS Circuits, Body-effect, the nMOS inverter, VLSI Design flow, Layers of abstraction, Stick Diagram, Design goals and layout diagrams. Complex Programmable Logic Devices (CPLD) –Generic CPLD architecture and Generic Logic block, Xilinx XC9500 CPLD family. Field Programmable Gate Arrays (FPGA) Application Specific Integrated Circuits (ASICs), System Design Using VHDL, VHDL for combinational circuits.

UNIT VI: ELECTRIC AND ELECTRONIC INSTRUMENTATION

General Analog Measuring Instruments: Permanent-magnet moving coil (PMMC) Galvanometer DC Ammeters, DC Voltmeters, Ohmmeters, multi-meters. AC meters: Electrodynamometers, rectifier type, thermo instruments. Electrodynamometers in power measurements, Watt-hour meter, Power-factor meter, Instrument Transformers. DC Bridges, AC Bridges Analog Measuring Instruments: Electronic voltmeters, AC Voltmeters, Analog frequency meter, Analog phase meter, Cathode Ray Oscilloscope. Digital voltmeters, Digital multimeter, Digital frequency meter, Digital phase meter, Q-meter, Digital storage oscilloscope, waveform generators.

UNIT VII: SCIENTIFIC/ANALYTICAL INSTRUMENTATION

Colorimeters, Spectrophotometers, Conductivity, pH Meters, Polarographs, Nuclear Magnetic Resonance Spectrometer, Electron Spin Resonance spectrometer, Mass Spectrometers, Photoacoustic spectrometer, Electron Microscopes, Thermal Analyzers and Chromatographs.
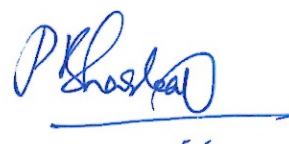
UNIT VIII: BIO MEDICAL ELECTRONICS

Block diagram of Medical Instrumentation System, General constraints in design of medical instrumentation system, Bioelectric Signals and Electrodes, Biomedical Transducers, Biopotential Amplifiers Biomedical Diagnostic Equipment: ECG, EEG, EMG, Sphygmomanometer, Respirometer, Imaging Techniques: MRI, X-RAY, CT. Biomedical Therapeutic Equipment: Pacemaker, Defibrillator, Surgical Diathermy, Laser, IR applications in Physiotherapy, Hemodialysis, Lithotriptor, Anesthesia machine, Heart-lung instrument, Ventilators, Nebulizers. Microcontroller/IoT based Bio medical applications.

UNIT IX: PROCESS INSTRUMENTATION

Temperature and Pressure Measurement Systems, Flow, Humidity and Moisture Measurement and control Systems Level, Density and Gases Measurement Systems, Process control elements: Proportional + Integral + Derivative (PID), Fuzzy Logic Controllers (FLC), hydraulic, Pneumatic and Electronic Controllers. Single loop controllers. Supervisory Control Systems, Distributed Control Systems (DCS), Programmable Logic Controllers (PLC).

UNIT X: C PROGRAMMING & MATLAB

Variables and Data types, Console I/O operations, Operators and Expressions , Control flow statements - If Statement, Switch Statement, Unconditional Branching using goto Statement, While Loop, Do While Loop, For Loop, Break and Continue, Special Cases. Functions, Arrays, Pointers, Strings, Structures, Unions, File handling in C Pointers. MATLAB toolboxes, MATLAB windows, Mathematical operations, Handling of matrices and arrays, command window I/P and O/P. Graphics: Plotting techniques, Graph components, Editing plots, Basic plotting functions, Simulink, Graphical User Interface.

BOOKS FOR STUDY AND REFERENCE:

1. C.R. Kothari, Research Methodology: Methods and Techniques, II Ed. New Age International Publishers, (2009).
2. Shanthibhushan Mishra, Shashi Alok, Handbook of Research Methodology, I Ed,
3. 2017, Edu creation Publishers.
4. Linear Integrated Circuits – Sanjay Sharma
5. Digital Systems –Principles & Applications –Ronaldo J Tocci & Meal S. Widmer
6. Instrumentation measurement & analysis –Nakra /Choudhary
7. Control Systems Engineering – Nagrath. I. J. & Gopal M.
8. Digital Design -principles and practices - John F. Wakerly ,3rd Edition, Pearson
9. Education
10. The 8051 Microcontroller: Architecture, Programming and Applications –K. J. Ayala
11. Electronic Instrumentation - H S Kalsi
12. Embedded Systems Architecture, Programming and Design- Raj Kamal
13. MATLAB – An introduction with Applications – Amos Gilat