VINAYAKA MISSION'S RESEARCH FOUNDATION
DEEMED TO BE UNIVERSITY
(Declared Under Section 3 of the UGC Act, 1956)

Faculty of Engineering & Technology

Common Research Methodology Syllabus

PART A – RESEARCH METHODOLOGY (Q.1–35)

1. Foundations of Research

- Nature, scope, and objectives of research
- Types of research: Historical, Ex-post facto, Action, Applied, Conceptual, Fundamental
- Research ethics: privacy, anonymity, validity, honesty, objectivity
- Essential qualities of a researcher
- Root meaning of 'research'

2. Research Process

- Steps: problem identification, literature review, hypothesis formulation, objectives, data collection, analysis, report writing
- Role of hypothesis in research
- Primary vs secondary data sources

3. Research Designs & Sampling

- Research methods: Observation, Survey, Philosophical, Experimental, Historical
- Research designs: Statistical, Observational, Operational
- Sampling techniques: probability & non-probability (random, stratified, cluster, quota, systematic)
- Counterbalancing in repeated measures design

4. Qualitative & Quantitative Research

- Qualitative approaches: Ethnographic, Grounded theory, Phenomenological
- Subjective assessment of attitudes, opinions, behaviors
- Quantitative focus: measurement, variables, attributes
- Types of variables: Independent, Dependent, Explanatory

5. Statistical Tools & Data Analysis

- Measures of central tendency (Mean, Median, Mode)
- Measures of dispersion (Range, Variance, Standard deviation)
- Correlation and regression analysis
- ANOVA, MANOVA, and factorial analysis
- Use of statistical association for attributes

6. Workshops, Seminars & Conferences

- Purpose of workshops, seminars, symposiums, conferences
- Sociogram technique for studying human relations

7. Academic Writing & Reporting

- Depth and quality of literature review
- Writing good research reports: clarity, audience, simplicity
- Proposal writing: elements of a well-written proposal
- Referencing and citation styles (APA, Harvard, Chicago, Vancouver)

PART B – Computer Science Engineering(Q.36–70)

1. Operating Systems

- Multiprogramming & multitasking concepts
- Process management – ready, waiting, execution queues
- Fragmentation – internal & external, paging &segmentation
- Memory management – access time, aging registers, page faults
- Scheduling methods & performance measures

2. Database Management Systems

- Entity-relationship concepts – strong & weak entities, keys, attributes
- Integrity constraints – entity integrity, referential integrity
- SQL operations – COUNT, DISTINCT, GROUP BY
- Data dictionary &metadata
- Keys – candidate key, super key, primary & foreign keys

3. Computer Networks

- ARPANET origins &IMPs
- OSI model – layers &functions
- Bandwidth & frequency calculations
- Flow control & error control protocols – Stop-and-Wait, Go-Back-N, Selective Repeat

4. Cryptography & Security

- Digital signatures &authentication
- Symmetric vs asymmetric cryptography
- Encryption & decryption algorithms

5. Software Engineering

- Agile methodologies – principles &practices
- System specification – functions, performance, constraints
- UML diagrams – activity, class, state (excluding data flow)
- Class responsibilities – attributes &operations
- Software quality – cohesion &coupling

6. Programming in C

- Storage classes – auto, extern, static
- Operators and associativity rules
- Loop constructs – for, while, do-while (missing conditions, termination)
- Header files for string operations (string.h, strcmp)

7. Algorithms & Data Structures

- Algorithm analysis – time complexity (Quick sort best/worst case)
- Searching algorithms – linear & binary search
- Traversing vs inserting vs deleting vs searching operations
- Linked lists – circular lists, advantages/disadvantages
- Dynamic programming, greedy algorithms (Fractional Knapsack, Prim’s algorithm)

Civil Engineering

PART B – (Q.36–70)

1. Structural Engineering

- Stress, strain & elastic constants
- Shear force & bending moment diagrams
- Basics of torsion & strain energy
- RCC design – slabs, beams, columns, footings
- Steel design – trusses, welded & bolted joints

2. Geotechnical Engineering

- Soil properties & classification (coarse vs fine soils)
- Shear strength basics (Mohr-Coulomb concept)
- Bearing capacity of shallow foundations
- Earth pressure basics & retaining walls

3. Construction Engineering & Management

- Building materials – cement, concrete, steel, modern alternatives
- Concrete mix design & durability
- Special concretes (lightweight, high strength)
- Construction methods: foundations, floors, roofs, formwork
- Basics of project planning (Bar charts, CPM/PERT intro)
- Safety & sustainability in construction

4. Environmental Engineering

- Water supply: sources, standards, basic treatment
- Wastewater: primary & secondary treatment
- Solid waste: collection & disposal basics
- Air,Noise and land : sources & control measures.

5. Surveying

- Chain surveying basics
- Simple leveling& contouring
- Awareness: Total Station, GPS.

6. Transportation Engineering

- Pavement types (flexible vs rigid)
- Super elevation & sight distance -basics
- Road materials basics

Mechanical Engineering

PART B – (Q.36–70)

1.Thermodynamics & Power Engineering

- Thermodynamic systems – open, closed, thermally isolated
- Laws of thermodynamics and absolute temperature scale (Kelvin)
- Applications: Refrigerators, gas compressors, power plants
- Isochoric, isenthalpic, steady-state processes
- Boilers – Lancashire boiler and classifications
- Steam condensers – effects of air leakage
- Critical pressure and latent heat of vaporization

2.Thermal & Fluid Systems

- Heat transfer – thermal conductivity (SI units)
- Nozzles and turbines – energy conversions, maximum kinetic energy design
- Pumps – conversion of mechanical to pressure/kinetic energy
- Bulk modulus of elasticity and compressibility
- Fluid mechanics: Airfoils (streamline vs bluff bodies)
- Dimensionless equations – Reynolds, Euler, Weber numbers
- Friction factor in pipes (dependence on Re number and roughness)

3.Strength of Materials & Machine Design

- Stress–strain behavior of plain carbon steel (<1.7% C)
- Hardness, toughness, and material properties of alloys (e.g., copper alloys)
- Idler gears in gear trains – functions and applications
- Shafts: line shaft vs countershaft
- Bearings, machine elements – supporting vs transmitting types
- Ergonomics vs aesthetics in design
- Factor of safety, analysis of forces, failure modes
- Reasons for product design & redesign: optimum design, innovation, appearance

4.Theory of Machines & Kinematics

- Kinematic pairs & chains (minimum required = 4 pairs)
- Gear trains & transmission – cone pulley drive, fast & loose pulleys, multiple belt drives
- Machine elements: sprockets, chains, axles as power-transmitting components

5.Manufacturing Processes

- Metal forming – extrusion, forging
- Metal joining – riveting, welding
- Sheet metal working – blanking, stamping
- Surface finishing – grinding, honing, buffing, lapping
- Lathe operations – taper turning, chamfering, facing, knurling
- Use of cone pulley in lathes (speed change, lead screw drive)

6.Applied Mechanics & Vibrations

- Flat surfaces in lathes (tool movement parallel vs perpendicular)
- Cantilever and beam deflections
- Vibration fundamentals – free, forced, and resonance

Electronics & Communication Engineering

PART B – (Q.36–70)

1. Electronic Devices & Circuits

- Diode characteristics and applications – rectifiers, clippers, clampers
- BJT, FET, and MOSFET – operation, biasing, small-signal models
- Amplifiers – CE, CB, CC configurations
- Oscillators – RC, LC, crystal oscillators
- Voltage regulators and power supplies

2. Analog & Digital Electronics

- Operational amplifiers – ideal characteristics, applications
- 555 timer IC – monostable and astableoperations
- Logic families – TTL, CMOS
- Combinational circuits – multiplexers, decoders, encoders
- Sequential circuits – flip-flops, counters, registers
- FSM & HDL
- VLSI Design flow

2. Signals & Systems

- Classification of signals – continuous, discrete, periodic, aperiodic
- Convolution and correlation
- Fourier series and Fourier transform
- Laplace transform and Z-transform
- Sampling theorem and reconstruction

3. Communication Systems

- Amplitude, frequency, and phase modulation
- AM, FM, and PM transmitters and receivers
- Pulse modulation – PAM, PWM, PPM
- Digital modulation – ASK, FSK, PSK, QPSK
- Noise analysis and signal-to-noise ratio (SNR)

4. Electromagnetic Theory

- Maxwell’s equations
- Wave propagation in free space and transmission lines
- Smith chart and impedance matching
- Waveguides and antennas
- Microwave components and devices

5. Control Systems

- Feedback principles
- Time-domain and frequency-domain analysis
- Stability criteria – Routh-Hurwitz, Nyquist, Bode plots
- Root locus techniques
- Compensators – lead, lag, PID

6. Microprocessors & Embedded Systems

- Architecture of 8085 and 8086 microprocessors
- Instruction sets and addressing modes
- Assembly language programming basics
- Microcontrollers – 8051 architecture and applications
- Embedded system applications in ECE

Biotechnology

PART B – (Q.36–70)

1. Molecular Biology
- DNA replication, transcription, translation
- Prokaryotic vs eukaryotic gene expression
- Gene regulation – operon concept
- Mutation and DNA repair mechanisms
- RNA processing and splicing

2. Recombinant DNA Technology
- Enzymes in genetic engineering – restriction enzymes, ligases
- Vectors – plasmids, phages, cosmids, BACs, YACs
- Gene cloning and expression systems
- PCR techniques and applications
- Genetically Modified Organisms (GMOs).

3. Applications in Medicine
- Gene therapy methods
- Production of vaccines using recombinant methods
- Stem cell technology and regenerative medicine
- Monoclonal antibodies
- Pharmacogenomics and personalized medicine

4. Proteins & Enzymes
- Protein structure – primary, secondary, tertiary, quaternary
- Protein folding and denaturation
- Enzyme kinetics – Michaelis-Menten equation
- Enzyme inhibition and regulation
- Industrial enzyme applications

5. Immunology
- Cells and organs of the immune system
- Antigen-antibody interactions
- Classes and functions of immunoglobulins
- Natural Killer (NK) cells and immune surveillance
- Types of hypersensitivity reactions

6. Bioinformatics
- Biological databases – KEGG, BLAST, STRING
- Next Generation Sequencing (NGS) data analysis
- Gene Ontology (GO) annotation
- Protein structure prediction tools
- Comparative genomics and proteomics

7. Systems Biology & Metagenomics

- Systems approach to biological processes
- Pathway modeling and simulation
- Metagenomics – environmental DNA analysis
- Microbiome studies
- Synthetic biology principles

Electrical & Electronics Engineering

PART B – (Q.36–70)

1. Network theory

- Circuit laws – KCL, KVL, network theorems
- Loop and node analysis
- Thevenin's and Norton's equivalents
- Resonance in electrical circuits
- Transient and steady-state analysis

2. Electromagnetism & Field Theory

- Coulomb's law, Gauss's law, Ampere's law
- Electromagnetic induction and Faraday's law
- Gradient, divergence, and curl
- Force on a current carrying conductor
- Maxwell's equations and applications

3. Electrical Machines

- DC machines – characteristics, losses, efficiency
- Transformers – equivalent circuit, efficiency, regulation
- Induction motors – types, slip, torque-speed characteristics
- Synchronous machines – operation, excitation, stability
- Special machines – single-phase motors, servo motors

4. Power Systems

- Generation methods – thermal, hydro, nuclear, renewable
- Transmission lines – parameters, performance, efficiency
- Per unit system and fault analysis
- Voltage regulation and stability
- Protective devices and switchgear

5. Control Systems

- Block diagrams and signal flow graphs
- Time-domain analysis – transient and steady state
- Stability criteria – Routh-Hurwitz, Nyquist, Bode plots
- Compensation techniques – lead, lag, PID
- State-space representation

6. Power Electronics

- Diodes, thyristors, MOSFETs, IGBTs
- Controlled rectifiers – single-phase and three-phase
- DC-DC converters (choppers)
- Inverters and cycloconverters
- Commutation techniques – voltage, current, load

7. Electric Vehicles (EV)

- • EV architecture and components
- • Electric propulsion and drive control
- • Battery technologies and management system (BMS)
- • Charging methods and Vehicle-to-Grid (V2G)
- • Power converters and regenerative braking

8. Renewable Energy Sources (RES): Smart Grid

- Concept and architecture of smart grids
- Smart meters and communication systems
- Cybersecurity and grid reliability
- Solar, wind, hydro, and biomass energy systems
- Energy storage and hybrid systems
- Grid integration and power quality

Biomedical Engineering

PART B – (Q.36–70)

1. Human anatomy & Physiology for Engineers

- Basic structure and function of organ systems
- Cardiovascular, respiratory, neural, and musculoskeletal systems
- Electrophysiology of nerves and muscles
- Biomechanics of joints and tissues

2. Biomedical Instrumentation

- Bioelectric signals – ECG, EEG, EMG
- Measurement and recording systems
- Amplifiers – instrumentation and isolation amplifiers
- Transducers and biosensors – temperature, pressure, flow
- Medical imaging – X-ray, CT, MRI, Ultrasound, PET

2. Medical Electronics

- Pacemakers and defibrillators
- Prosthetic and assistive devices
- Implantable biomedical devices
- Biomedical signal processing basics
- Wearable health monitoring devices

3. Biomaterials & Tissue Engineering

- Properties and classification of biomaterials
- Biocompatibility and corrosion resistance
- Polymers, ceramics, metals in medical applications
- Scaffolds, stem cells, regenerative medicine
- Artificial organs and prosthesis design

4. Rehabilitation Engineering

- Orthotics and prosthetics
- Assistive devices for mobility and communication
- Rehabilitation robotics
- Design considerations for differently abled persons

5. Biomechanics & Medical Physics

- Biomechanical modeling of human systems
- Fluid mechanics in circulation and respiration
- Stress, strain, and material properties of tissues
- Radiation physics in medical applications
- Dosimetry and safety standards

6. Healthcare Technology & Bioinformatics

- Hospital equipment management
- Medical imaging and signal processing techniques
- Telemedicine technologies
- Electronic health records (EHR)
- Biological databases – protein, gene, pathways
- Applications of AI and machine learning in healthcare