Information regarding PhD admission Test 2020

1. The admission test (written test) and interview / viva-voce for admission of students in the PhD programmes would be conducted through online mode.
2. Admission test would be of 50 marks and duration of the test would be 1 hour and 30 minutes.
3. The written test would carry 50% questions from the Research Methodology and 50% questions would be subject specific.
4. Adequate arrangement for monitoring the students (through video conferencing) while appearing in the written examination would have to be done. Recording of the same may be kept by the respective departments for future reference.
5. Qualifying mark for appearing in interview / viva voce is 50% mark in written test.
6. Schedule of the PhD admission process would be as follows:

Written Test:	28-09-2020
Viva-voce:	29-09-2020
Declaration of result:	30-09-2020
Admission of selected students:	01-10-2020 to 05-10-2020
Starting of Classes for the course works:	05-10-2020

Syllabus for PhD Admission Test 2020

1. Department of Instrumentation Engineering:

Research Methodology:

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Instrumentation Engineering:

Electrical Circuits

Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, mutual inductance and capacitor; transient analysis of RLC circuits with dc excitation.
Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems. Peak-, average- and rms values of ac quantities; apparent-, active- and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements. transient analysis of RLC circuits with ac excitation.

Signals and Systems

Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second-order linear time-invariant systems, impulse response of systems; convolution, correlation. Discrete-time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

Control Systems

Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, PI, PID, cascade, feedforward, and ratio controllers, tuning of PID controllers and sizing of control valves.

Analog Electronics

Characteristics and applications of diode, Zener diode, BJT and MOSFET; small-signal analysis of transistor circuits, feedback amplifiers. Characteristics of ideal and practical operational amplifiers; applications of opamps: adder, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier, precision rectifier, active filters, oscillators, signal generators, voltage-controlled oscillators and phase-locked loop, sources and effects of noise and interference in electronic circuits.

Digital Electronics

Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flipflops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to-digital (successive approximation, integrating, flash and sigma-delta) and digital-to-analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems, Embedded Systems: Microprocessor and microcontroller applications, memory and input-output interfacing; basics of data acquisition systems, basics of distributed control systems (DCS) and programmable logic controllers (PLC).

Measurements

SI units, standards (R,L,C, voltage, current and frequency), systematic and random errors in measurement, expression of uncertainty - accuracy and precision, propagation of errors, linear and weighted regression.

Wheatstone, Kelvin, Megohm, Maxwell, Anderson, Schering and Wien bridge for measurement of R, L, C and frequency, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument

transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

Sensors and Industrial Instrumentation

Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (variable head, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement. 4-20 mA two-wire transmitter.

2. Department of Multimedia Communication and Design:

- **Understanding of Research Methodology:**

Research Design, Need and types of Research Design, Understanding of Literature Survey/ Review, Identification of research problem – Selection Understanding, Types of Research Methods, Concept of Sampling, Data Collection & Analysis Methods, Tools and Techniques, Research Design ethics.

- **Design thinking, Problem Identification Skills and problem solving:**

Candidates must be able to recognize the user and the context, knowledge of properties of materials and their felicitous use in design and many more and the user and the constraints and select the most relevant solution for the given design problem.

- **Observation and design sensitivity:**

Candidates must have the ability to observe the hidden properties in day to day life and think rigorously about them. Aspiring students must be able to notify the variance in visual properties and aesthetic outcomes.

- **Drawing & Creativity:**

Aspiring candidates must be skilled in drawing products, people or scenes, together with good line quality, composition, proportion, perspective, and shading.

Candidates must have the ability of lateral thinking and suggest solitary along with diverse solutions.

- **Communication Skills** - Students must have good communication skills. Candidates must be able to convey concept and idea distinctively by virtue of text and visuals.

3. Department of Food Engineering & Technology

Unit 1: Introductory Food Technology

Introduction to food technology. Food processing industries/institutions/food scientists of importance in India. Food attributes viz. colour, texture, flavour, nutritive value and consumer preferences. Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water

activity and its relation to spoilage of foods. Spoilage of processed products and their detection. Principles and methods of food preservation. Food fortification, Composition and related quality factors for processing. Methods of food preservation such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies (microfiltration, bacteriofugation, ultra high voltage electric fields, pulse electric fields, high pressure processing, irradiation, thermosonication), alternate-thermal technologies (ohmic heating, dielectric heating, infrared and induction heating) and biological technologies (antibacterial enzymes, bacteriocins, proteins and peptides) in food processing.

Unit 2: Technology of Foods of Plant Origin

(a) Fruits and Vegetable Processing: Post harvest handling and storage of fresh fruits and vegetables. Preparation of fruits and vegetables for processing. Minimally processed products. Cold chain logistics. ZECC (Zero Energy Cool Chambers), CCSR (Charcoal cool storage Rooms) Thermal processing and process time evaluation for canned products, process optimization, aseptic canning, methods for canning of different fruits, and vegetables; Dehydration and associated quality changes during drying and storage of dehydrated products. Solar drying. Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices in non-fermented/ fermented/ aerated beverages, health drinks. Membrane technology. Chemistry and manufacture of pectin, role in gel formation and products like jellies and marmalades. Technology of preservatives, pickles, chutney's and sauces. Nature and control of spoilage in these products. Re-structured fruits and vegetables. By products utilization of fruits and vegetable processing industry. Processing methods of frozen fruits and vegetables, IQF products, packaging, storage and thawing. Role of Pectinases. Tomato products such as juice, puree, paste, soup, sauce and ketchup. Other convenience foods from fruits and vegetables. Beverages, tea, cocoa and coffee processing. Medicinal and aromatic plants: their therapeutic values. Spice Processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential.

(b) Food grain Processing: Structure, composition of different grains like wheat, rice, barley, oat, maize and millets. Anti-nutritional factors in food grains and oilseeds. Milling of grains. Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes, doughnuts, buns, pasta goods, extruded, confectionary products, breakfast and snack foods. Rheology of wheat and rice flour. Preparation of vital wheat gluten and its utilization. Instant ready mixtures. Enzymes (amylases and proteases) in milling and baking. Milling and parboiling of rice; by-products of rice milling and their utilization. Processed products from rice. Pearling, malting, brewing and preparation

of malted milk feeds from barley. Significance of ß-glucans. Milling of oats and its processing into flakes, porridge and oatmeal. Wet and dry milling of corn, manufacture of corn flakes, corn syrup, corn starch, corn steep liquor and germ oil. Structure and composition of pulses and their importance in Indian diet. Milling and processing of pulses viz. germination, cooking, roasting, frying, canning and fermentation. Use in traditional products, protein concentrates and isolates. Modified starches and proteins. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing. Oil extraction and its processing, by- products of oil refining. Production, packaging and storage of vanaspati, peanut butter, protein concentrates, isolates and their use in high protein foods. Export of oilseed cakes. International market and consumer preferences for quality in cakes for use in textured vegetable proteins. Millets: composition, nutritional significance, structure and processing. Dairy analogues based on plant milk. Spices Processing: Oleoresin and essential oil extraction

Unit 3: Technology of Foods of Animal Origin

(a) Technology of Milk and Milk Products: Milk and Milk production in India. Importance of milk processing plants in the country. Handling and maintenance of dairy plant equipment. Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk. Problems of milk supply in India. UHT, toned, humanized, fortified, reconstituted and flavoured milks. Technology of fermented milks. Milk products processing viz. cream, butter, *ghee*, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice-cream, butter oil, *khoa*, *channa*, *paneer* and similar products. Judging and grading of milk products. Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing. In sanitization viz. selection and use of dairy cleaner and sanitizer. In plant cleaning system. Scope and functioning of milk supply schemes and various national and international organizations. Specifications and standards in milk processing industry. Dairy plant sanitation and waste disposal.

(b) Technology of Meat / Fish / Poultry Products: Scope of meat, fish and poultry processing industry in India. Chemistry and microscopic structure of meat tissue. Ante mortem inspection. Slaughter and dressing of various animals and poultry birds. Post mortem examination. Rigor mortis. Retails and wholesale cuts. Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Sausage making. Microbial factors influencing keeping quality of meat. Processing and preservation of fish and its products. Handling, canning, smoking and freezing of fresh water fish and its products. Meat tenderization and role of enzymes in meat processing. Utilization of by-products. Zoovosic diseases. Structure and composition of egg and factors effecting quality. Quality measurement. Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics. Packing, storage and transportation of eggs. Technology of egg

products viz. egg powder, albumen, flakes and calcium tablets. Industrial and food user physiological conditions and quality of fish products.

Unit 4: Food Quality Management

Objectives, importance and functions of quality control. Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. The principles and practices of food plant sanitation. Food and hygiene regulations. Environment and waste management. Total quality management, good management practices, HACCP and codex in food. International and National food laws. US-FDA/ISO-9000 and FSSAI. Food adulteration, food safety. Sensory evaluation, panel screening, selection methods. Sensory and instrumental analysis quality control. Quality control of food at all stages and for packaging materials. Non-destructive food quality evaluation methods.

Unit 5: Food Engineering/Packaging and Labelling

Unit operations of food processing viz. grading, sorting, peeling and size reduction machineries for various unit operations, energy balance in food processing. Packaging materials viz. properties and testing procedures, packaging of fresh and processed foods. Shelf life studies. Recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging. Nutritional labelling requirements of foods. Requirements and functions of containers. Principles of package design.

Unit 6: Food Microbiology & Biotechnology

Fermentation technology, fermented food products (animal and plant based), microbial spoilage of foods, bacterial growth curve, hurdle technology. Role of biotechnology in productivity of plants, livestock and microbes of improved nutrition and quality. Use of biotechnology in production of food additives viz. preservatives, colorants, flavours. Use of biotechnologically improved enzymes in food processing industry, biomass production using industrial wastes. Single cell proteins, Food contaminants viz. aflatoxins. Food intoxication and infection. Consumer concerns about risks and values, Biotechnology and food safety.

Unit 7: Flavour Chemistry Technology

Flavour composition of foods/beverages (identification and quantitative analysis of the flavour precursors and their products, characterization of the staling reaction using stable isotopes). Flavour composition of foods/beverages in relation with maturation and microbial activity/or the processing conditions (e.g. fermented dairy products, beer, wine, honey, fruits). Analysis of odour-active compounds of food/beverages (Charm analysis). Synthesis of flavour by microorganisms and plant cells. Lipid derived flavours. Investigation of equilibrium of key flavour compounds that govern the flavour stability of beverages. Natural antioxidant constraints in spices. Role of microorganisms in flavour development. Flavor emulsions, flavour composites, essential oils and oleoresins.

Unit 8: Consumer Sciences / Food Product Development / Health Foods

Socio-cultural, psychological and economical consideration for food appearance, domestic and export marketing. Consumer trends and their impact on new product development. Product development viz. to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Role of food in human nutrition. Nutritional disorders, natural contaminants and health hazards associated with foods. Diet therapy. Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods.

Syllabus on Research Methodology

Unit 1: Basic concepts on research

• Identification of rresearch problem • Rationale of research • Research objectives • Types of research – fundamental / applied / action / quantitative / qualitative • Research design

Unit 2: Review of literatures

• Primary source • Secondary source • E-resources and search engines • Searching data base • Writing literature review.

Unit 3: Methods of research

• Concept and formulation of hypothesis • Survey method and / or Experimental method (variable, designs) • Historical methods • Content analysis

Unit 4: Sampling of data

• Concept of sampling • Probability sampling techniques • Non probability sampling techniques • Sampling error

Unit 5: Collection of data

• Primary data generation • Secondary data collection • Methods of data generation / collection – by experiments, questionnaire, interview schedule, focus groups etc

Unit 6: Data Analysis

• Statistical analysis techniques • Qualitative analysis techniques • Application of computer in research data analysis

Unit 7: Preparation of Research Report

• Structure and component of research report • Organization of data • Indexing of journal and research output • Citation, references, bibliography • Copyright, plagiarism, originality of research work

Unit 8: Research ethics

• Ethics in research • National and International regulations / laws / ethics related to research on Human, Animals and Environments

4. Department of Civil Engineering Department

INSTRUCTIONS: A candidate would be required to choose questions from any one of the four Subject-specific sections I, II, III and IV besides answering questions from the Common Section on Research Methodology.

Common Section: Research Methodology

Meaning, objectives and types of research: Meaning, objectives and scope of research; Research methods vs. Research Methodology; Prerequisites of research; Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Research Problem: Meaning of research problem; Sources of research problem; Characteristics of a good research problem;

Literature Review: Purpose of the review; Identification of literature relevant to research interest; Organizing literatures for further research.

Data Collection (Sampling): Population and sample; Characteristics of a good sample; Techniques of sample Selection; Types of data in research

Tools of Data Collection: Types of data collection tools.

Descriptive Statistics Tabulation, Organization, and Graphical Representation of Quantitative data Measures of Central Tendencies: Mean, Median, Mode Measures of Variability: Range, Quartile Deviation, Standard Deviation,

Research Reporting: Format of the research report; Style of writing report, journal article, conference papers, etc., Referencing literature in text and in bibliography.

Ethics and IPR: Ethical issues; Commercialization of research; Copy right; Royalty; Intellectual property rights and patent law; Trade Related aspects of Intellectual Property Rights; Reproduction of published material – Plagiarism, Citation and acknowledgement.

Subject-specific Section I: Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils –

Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

Subject-specific Section II: Water Resources and Hydraulic Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's law.

Subject-specific Section III: Environmental Engineering

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Green energy: Development of alternative fuels, new means of generating energy, energy efficiency, storage and distribution, modeling and waste management. Wind Energy & Small Hydropower System, Solar Photovoltaic Energy Conversion, Processing of Green Energy Materials, Solar Thermal Energy Conversion, Waste to Energy Conversion, Green Management.

Subject-specific Section IV: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations;

Strength of Materials: Internal forces in structures bending moment and shear force in statically determinate beams;

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods;

Design of RCC Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length;

Prestress Concrete: Prestressed concrete beams.

Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis - beams and frames.

Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete -Constituents, mix design, short-term and long-term properties.

Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

5. Department of Computer Science and Engineering

Research Methodology:

Motivation of the Research, Definition of Research Problem, State of Art, Experimental Design; Processing and Analysis of data; Research ethics. Publication. Research tools.

CSE:

Mathematics: Number system, Sets, Relations, Functions, Counting, Recurrence relations.

Algorithm: Space and time complexity measures, asymptotic notation, worst case and average case analyses, lower and upper bounds

Data structure: Array, Linked List, Stack, Queue, Tree, Graph, Search Trees, Hashing.

Concept of programming in C-language: Basic C-language syntax, Data type, Decision making, Loops, Functions, Pointer, Array, Structure, Sorting and searching Algorithms.

Theory of computation: DFA, NFA, Regular expression, Grammar, PDA

OS: Basic concept of OS, Process, Scheduling, Memory management.

Networking: OSI model, TCP/IP protocol suit. IPv4.

6. Department of Electrical Engineering

Research Methodology:

An overview of research methodology, setting up a research project, methodology of analysing quantitative data, methodology of analysing quanlitative data, writing about research.

Basic Electrical Engineering:-

Ohm's law, Kirchhoff's laws, mesh analysis, loop analysis, network theorems, magnetism, electromagnetism, single phase AC circuit, complex number, phasor diagram, three phase AC circuit, instruments and measurements.

Electrical Machines:-

Transformer: basic principles, construction, EMF equation, phasor diagram, equivalent circuit, open circuit test, short circuit test, losses, efficiency, voltage regulation.

DC machines: construction, types of DC machines, armature reaction, characteristics, losses, efficiency.

Induction motor: construction, rotating mmf, equivalent circuit, power flow, losses, efficiency.

Power Systems:-

Fundamentals of power systems, line constant calculations, capacitance of transmission lines, corona, transients in power systems, power system stability, load flows, economic load dispatch, relays and circuit breaker, symmetrical components and fault.

7. Department of Humanities and Social Sciences

1. **Subject: English (**Area: Language and Linguistics, Cultural Studies, English Language Teachings (ELT), Language Teachings)

Research Methodology:

Meaning and objectives of research, Types of research, Research Problems, The Hypothesis, Survey testing, Questionnaire, Tools and Techniques of research, Selecting a problem and preparing a research proposal, Methods of data collection, Research questions, Writing Research Report: Abstract, Synopsis, Style of writing, Body, Reference, Footnotes etc.

Language and Linguistics:

Language: Meaning and rules, Language and Communication, Concepts in Lingusitcs, Language Families, Historical Comparative Linguistics, Sociolinguistics, Stylistics, The role of culture in language, Language Development and Language Maintenance

Cultural Studies:

Introduction to cultural studies, Folklore and Culture, Society and Culture, Cultural Policies and Cultural Industries, Ethnicity Identity and culture, Cultural Studies and Media, Cultural Heritage Management

ELT and Language Teachings:

Theories of Language Learning, First Language Acquisition vs. Second Language Learning, Teaching materials, Sociolinguistics context of English Teachings in India.

2. Subject: Economics

Research Methodology:

Meaning and objectives of research, types of research, selecting a problem and preparing a research proposal, research design, sampling design, measurement and scaling techniques, methods of data collection, processing and analysis of data, research questions, testing of hypothesis both parametric and nonparametric test.

Indian Economy:

Basic Problem of Indian Economy, Current Indian Economic Situation, Rural Development: Issues Challenges and policy responses , Urban Development : Issues , Challenges and Policy responses , Issues of Economic growth and Development , Social Sector Development : Health , Education and Gender , Agricultural and Industrial Development : Major Challenges and Policy Responses , Sustainable Development : Meaning and Implementation issues in India.

Technology and Economics:

E-commerce : concept and use , E – Governance System in India , Start up concept and government policy , Modern marketing concept for promotion of Entrepreneurship , Present Business and Incubation promotion Policy of Government of India.

8. Department of Mathematics

PART-A: RESEARCH METHODOLOGY IN MATHEMATICS

Unit-1: Introduction: What research basically means, Research need and implication, Brief history and expectation, Research ethics, Plagiarism, Prospects of a researcher career, Basic preparation and requirement.

Unit-2: Objectives and types of research: Motivation and objectives, Research methods vs. methodology, Type of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Unit-3: Research Formulation: Defining and formulating research problem, Selecting problem, Necessity of defining the problem, Importance of literature review in defining a problem, Literature review-primary and secondary sources of literature- reviews, treatise, monographs-patents, web as a source-searching the web, critical literature review- identifying gap areas from literature review, Development of working hypothesis. Formulation and steps of the research proposal.

Unit-4: Research design and method: Basic Principles, Need of research design-Feature of a good design, Important concepts relating to research design- Observations and Facts, Laws and Theories, Prediction and Explanation, Induction, deduction, development of Models. Research plan development-Exploration, Diagnosis, Experimentation. Experiment and Sample designs..

Unit-5: Data collection and Analysis: Observation and collection of data- primary and secondary data, Methods of collection of data-Sampling methods, Data processing and analysing strategies, Data analysis with statistical methods, Hypothesis testing, Generalization and Interpretations.

Unit-6: Reporting and thesis writing: Structure and components of scientific reports- Poster, Journal paper, Technical report and Thesis, Book and book chapters. Significance of different steps in preparation-Layout, Structure and Language of different reports, Illustrations and Tables, Bibliography, Referencing and Foot note, End note. Oral presentation-planning, Preparation, Practice, Making presentation-use of Audio-visual aid, Importance of effective communication.

Unit-7: Documentation and research output assessment: Research communication and publication, Impact factor and citation, Scientific Citation Index and Extended list, H-index and i-10 index, Patent and royalty.

PART-B :MATHEMATICS

Real Analysis: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Modern Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear

transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms. **Topology**: basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

Numerical Analysis:

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Calculus of Variations:

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Linear Integral Equations:

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

Ordinary Differential Equations (ODEs):

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs.General theory of homogenous and non-homogeneous linear ODEs, variation of parameters,Sturm-Liouville boundary value problem, Green's function.

Partial Differential Equations (PDEs):

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Classical Mechanics:

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

STATISTICS

Descriptive statistics, exploratory data analysis Sample space, discrete probability, independent

events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities.

9. Department of Chemistry:

PART A: RESEARCH METHEODOLOGY

Research Methodology: Definition of problem: Necessity of defining problem, Technique involved in defining a problem. Surveying the available literature.

Research Ethics: Ethics in research, Plagiarism, Copy rights, Copy left, Patents, Acknowledgements, Review.

Research Design and techniques involved to solve problems: Subject of study; Place of study; Reason of such study; Type of data required; Method of data collection; Periods of study; Style of data presentation, Different methods used to solve a problem

Developing a research plan: Research objective; Informations required for solving the problem; Each major concept should be defined in operational terms; An overall description of the approach should be given and assumption if considered should be clearly mentioned in research plan; The details of techniques to be adopted.

Data collection and analysis: Experimental methods. Various measures of relationship often used in research studies, Correlation coefficients.

Computer knowledge: Basic of Computer Operating System: Using Windows – Directory structures – command structure (Document preparation, EXCEL, Power Point Presentation). Basics of Editing and Word processing.

Web Browsing for Research: Usage of Webs as a tool for scientific literature survey.

Error Analysis: Basics of a measurement and its interpretation, mean, standard deviation, variance, correlation coefficient; Usage of packages (e.g. ORIGIN; EXCEL) for data analysis.

Curve Fitting: Linear and Non-linear fitting of data

Presentation and Publications: Thesis, Research Paper, Review Article & Technical Reports, Publication in Conference, Publication in Journal, Quality Indices of Research, Impact Factor, Immediacy Factor, H-index

PART B: CHEMISTRY

Inorganic Chemistry:

1. Chemical periodicity 2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory). 3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents. 4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds. 5. Transition elements and coordination

compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms. 6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications. 7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis. 8. Cages and metal clusters. 9. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods. 10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine. 11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques. 12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Physical Chemistry:

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling. 2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications. 3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle. 4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems. 5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules. 6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance. 7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions. 8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems. 9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; DebyeHuckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations. 10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions. 11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis. 12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids. 13. Polymer chemistry: Molar masses; kinetics of

polymerization. 14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Organic Chemistry 1.

IUPAC nomenclature of organic molecules including regio- and stereoisomers. 2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. 3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions. 4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. 5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways. 6. Common named reactions and rearrangements – applications in organic synthesis. 7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations. 8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups. 9. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic. 10. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry. 11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S). 12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids. 13. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

Interdisciplinary topics:

1. Chemistry in nanoscience and technology. 2. Catalysis and green chemistry. 3. Medicinal chemistry. 4. Supramolecular chemistry. 5. Environmental chemistry

10. Department of physics

<u>Research Methodology</u>

1. **Basic concepts of research:** Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem – Research Design
2. **Types and methods of research:** Classification of research, basic and applied research – similarities and differences, interdisciplinary research, case study, field study, survey of

research fields, and methods of research as applied to basic and applied sciences – a few examples.

3. **Data Collection and Presentation:** Objectives and classification of data, data organization, presentation and interpretation – general concepts and methods, use of computers and related software for data collection, analysis and interpretation.
4. **Ethics in Research:** General ideas on presentation of scientific research, dissemination of research findings - different methods such as publishing reports, patents and patent rules, presentation of work in conferences, ethics and norms to be followed in presentation of research findings, plagiarism and its consequences, how to avoid plagiarism in scientific research – a few case study.
5. **Scientific Report Writing:** Basic motivation for writing scientific report, content of a research report – a few case study, methods of preparing research reports, use of computers in preparing reports, quantification of quality of research disseminated through journals or patents.
6. **Experimental Methods in Physics:** Low temperature techniques and measurements, High vacuum production techniques, handling and related measurements, Radiation detection techniques and measurements, electronics, measurements and data acquisition techniques as applied to experiments, a few selected topics. Attending seminars, colloquia and interaction with the scientists. 2. Computational and Numerical Methods
7. **C programming language:** Overview and basic concepts, data types, flow control, functions, pointers, arrays, structure, inputs / outputs, make file, libraries, parallelization, concepts of object-orientation.
8. **Numerical methods:** Introduction and sources of computational errors, solution of non-linear equations (Root finding), solution of system of linear equations, numerical interpolation, numerical differentiation and integration, solution of differential equations, solution of partial differential equations.
9. **Data analysis:** Classification of errors, error propagation, basics of Monte Carlo techniques, data interpretation using Bayesian approach.

PART 'A' CORE

I. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent

series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

II. **Classical Mechanics**

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics-moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity-Lorentz transformations, relativistic kinematics and mass–energy equivalence.

III. **Electromagnetic Theory**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV. **Quantum Mechanics**

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

V. **Thermodynamic and Statistical Physics**

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

VI. **Electronics and Experimental Methods**

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-

electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting,

PART 'B' ADVANCED

I. Mathematical Methods of Physics

Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

II. Classical Mechanics

Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

III. Electromagnetic Theory

Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

IV. Quantum Mechanics

Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

V. Thermodynamic and Statistical Physics

First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

VI. Electronics and Experimental Methods

Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques.

High frequency devices (including generators and detectors).

VII. **Atomic & Molecular Physics**

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. **Condensed Matter Physics**

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. **Nuclear and Particle Physics**

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.
