English

The aim of the paper is to test the candidate's ability to read and understand serious discursive prose, and to express his ideas clearly and correctly in English/Indian language concerned.

The pattern of questions would be broadly as follows :-

(i) Comprehension of given passages.

(ii) Precise Writing

(iii) Usage and Vocabulary

(iv) Short Essay

Essay

Candidates will be required to write an essay on a specific topic. The choice of subjects will be given. They will be expected to keep closely to the subject of the essay to arrange their ideas in orderly fashion, and to write concisely. Credit will be given for effective and exact expression.

General Studies

The nature and standard of questions in these papers will be such that a well-educated person will be able to answer them without any specialized study. The questions will be such as to test a candidate's general awareness of a variety of subjects, which will have relevance for a career in Civil Services.

(a) **History of Modern India and Indian Culture**

The History of Modern India will cover history of the Country from about the middle of nineteenth century and would also include questions on important personalities who shaped the Freedom Movement and Social reforms. The part relating to Indian Culture will cover all aspects of Indian Culture from the ancient to modern times.

(b) **Geography of India**

In this part, questions will be on the physical, economic and social geography of India.

(c) **Indian Polity**

This part will include questions on the Constitution of India, Political system and related matters.

(d) **Current National issues and topics of social relevance**

This part is intended to test the Candidate's awareness of current national issues and topics of social relevance in the present-day India, such as the following.

Demography & Human Resource & related issues. Behavioural & Social issues & Social Welfare problems, such as child labour, gender equality, adult literacy, rehabilitation of the handicapped and other deprived segments of the society, drug abuse, public health etc.

Law enforcement issues, human rights, corruption in public life, communal harmony etc.

Internal Security and related issues.

Environmental issues, ecological preservation, conservation of natural resources and national heritage.

The role of national institutions, their relevance and need for change.

(a) **India and the World**

This part is intended to test candidate's awareness of India's relationship with the world in various spheres, such as the following:-

Foreign Affairs

External Security and related matters

Nuclear Policy

Indians abroad

(b) **Indian Economy**

In this part, questions will be on the planning and economic development in India, economic & trade issues, Foreign Trade, the role and functions of I.M.F., World Bank, W.T.O. etc.

(c) **International Affairs & Institutions**

This part will include questions on important events in world affairs and on international institutions.

(d) **Developments in the field of science & technology, communications and space**

In this part, questions will test the candidate's awareness of the developments in the field of science & technology, communications and space and also basic ideas of computers.

(e) **Statistical analysis, graphs and diagrams**

This part will include exercises to test the candidate's ability to draw common sense conclusions from information presented in statistical, graphical or diagrammatical form and to point out deficiencies, limitations or inconsistencies therein.

Agriculture – Optional

Ecology and its relevance to man, natural resources, their sustainable management and conservation. Physical and social environment as factors of crop distribution and production. Climatic elements as factors of crop growth, impact of changing environment on cropping pattern as indicators of environments. Environmental pollution and associated hazards to crops, animals, and humans.

Cropping pattern in different agro-climatic zones of the country. Impact of high-yielding and short-duration varieties on shifts in cropping pattern. Concepts of multiple cropping, multistorey, relay and inter-cropping, and their importance in relation to food production. Package of practices for production of important cereals, pulses, oil seeds, fibres, sugar, commercial and fodder crops grown during Kharif and Rabi seasons in different regions of the country.

Important features, scope and propagation of various types of forestry plantations such as extension, social forestry, agro-forestry, and natural forests.

Weeds, their characteristics, dissemination and association with various crops; their multiplication; cultural, biological and chemical control of weeds.

Soil-physical, chemical and biological properties. Processes and factors of soil formation. Modern classification of Indian soils, Mineral and organic constituents of soils and their role in maintaining soil productivity. Essential plant nutrients and other beneficial elements in soils and plants. Principles of soil fertility and its evaluation for judicious fertiliser use, integrated nutrient management. Losses of nitrogen in soil, nitrogen-use efficiency in submerged rice soils, nitrogen fixation in soils. Fixation of phosphorus and potassium in soils and the scope for their efficient use. Problem soils and their reclamation methods.

Soil conservation planning on watershed basis. Erosion and run-off management in hilly, foot hills, and valley lands; processes and factors affecting them. Dry land agriculture and its problems. Technology of stabilising agriculture production in rainfed agriculture area.

Water-use efficiency in relation to crop production, criteria for scheduling irrigations, ways and means of reducing run-off losses of irrigation water. Drip and sprinkler irrigation. Drainage of water-logged soils, quality of irrigation water, effect of industrial effluents on soil and water pollution.

Farm management, scope, important and characteristics, farm planning. Optimum resources use and budgeting. Economics of different types of farming systems.

Marketing and pricing of agricultural inputs and outputs, price fluctuations and their cost; role of co-operatives in agricultural economy; types and systems of farming and factors affecting them.

Agricultural extension, its importance and role, methods of evaluation of extension programmes, socio-economic survey and status of big, small, and marginal farmers and landless agricultural labourers; farm mechanization and its role in agricultural production and rural employment. Training programmes for extension workers; lab-to-land programmes.

Cell Theory, cell structure, cell organelles and their function, cell division, nucleic acids-structure and function, gene structure and function. Laws of heredity, their significance in plant breeding. Chromosome structure, chromosomal aberrations, linkage and cross-over, and their significance in recombination breeding. Polyploidy, euploid and an euploids. Mutation-micro and macro-and their role in crop improvement. Variation, components of variation. Heritability, sterility and incompatibility, classification and their application in crop improvement. Cytoplasmic inheritance, sex-linked, sex-influenced and sex-limited characters.

History of plant breeding. Modes of reproduction, selfing and crossing techniques. Origin and evolution of crop plants, centre of origin, law of homologous series, crop genetic resources-conservation and utilization. Application of principles of plant breeding to the improvement of major field crops. Pure-line selection, pedigree, mass and recurrent selections, combining ability, its significance in plant breeding. Hybrid vigour and its exploitation, backcross method of breeding, breeding for disease and pest resistance, role of interspecific and intergeneric hybridization. Role of biotechnology in plant breeding. Improved varieties, hybrids, composites of various crop plants.

Seed technology, its importance. Different kinds of seeds and their seed production and processing techniques. Role of public and private sectors in seed production, processing and marketing in India.

Physiology and its significance in agriculture. Imbibition, surface tension, diffusion and osmosis. Absorption and translocation of water, transpiration and water economy.

Enzymes and plant pigments; photosynthesis-modern concepts and factors affecting the process, aerobic and nonaerobic respiration; C, C and CAM mechanisms. Carbohydrate, protein and fat metabolism.

Growth and development; photoperiodism and vernalization. Auxins, hormones, and other plant regulators and their mechanism of action and importance in agriculture. Physiology of seed development and germination; dormancy.

Climatic requirements and cultivation of major fruits, plants, vegetable crops and flower plants; the package of practices and their scientific basis. Handling and

marketing problems of fruit and vegetables. Principal methods of preservation of important fruits and vegetable products, processing techniques and equipment. Role of fruits and vegetables in human nutrition. Raising of ornamental plants, and design and layout of lawns and gardens.

Diseases and pests of field vegetables, orchard and plantation crops of India. Causes and classification of plant pests and diseases. Principles of control of plant pests and diseases Biological control of pests and diseases. Integrated pest and disease management. Epidemiology and forecasting.

Pesticides, their formulations and modes of action. Compatibility with rhizobial inoculants. Microbial toxins.

Storage pests and diseases of cereals and pulses, and their control.

Food production and consumption trends in India. National and international food policies. Production, procurement, distribution and processing constraints. Relation of food production to national dietary pattern, major deficiencies of calorie and protein.

Animal Husbandry and Veterinary Science

1. Animal Nutrition-Energy sources, energy, metabolism and requirements for maintenance and production of milk, meat, eggs and wool. Evaluation of feeds as sources of energy.

1.1. Trends in protein nutrition: sources of protein metabolism and synthesis, protein quantity and quality in relation to requirements. Energy protein ratios in ration.

1.2. Minerals in animal diet : Sources, functions, requirements and their relationship of the basic minerals nutrients including trace elements.

1.3. Vitamins, Hormones and Growth Stimulating, substances : Sources, functions, requirements and inter-relationship with minerals.

1.4. Advances in Ruminant Nutrition-Dairy Cattle: Nutrients and their metabolism with reference to milk production and its composition. Nutrient requirements for calves, heifers, dry and milking cows and buffaloes. Limitations of various feeding systems.

1.5 Advances in Non-Rumiant Nutrition-Poultry-Nutrients and their metabolism with reference to poultry, meat and egg production, Nutrients requirements and feed formulation and broilers at different ages.

1.6 Advances in Non-Ruminant Nutrition-Swine-Nutrients and their metabolism with special reference to growth and quality of meat production, Nutrient requirement and feed formulation for baby-growing and finishing pigs.

1.7. Advances in Applied Animal Nutrition-A critical review and evaluation of feeding experiments, digestibility and balance studies. Feeding standards and measures of food energy. Nutrition requirements for growth, maintenance and production. Balanced rations.

2. Animal Physiology

2.1 Growth and Animal Production :-Prenatal and postnatal growth, maturation, growth curves, measures of growth, factors affecting growth, conformation, body composition, meat quality.

2.2 Milk Production and Reproduction and Digestion : Current status of hormonal control of mammary development, milk secretion and milk ejection. Male and Female reproduction organ, their components and function. Digestive organs and their functions.

2.3 Environmental Physiology : Physiological relations and their regulation; mechanisms of adaption, environmental factors and regulatory mechanism involved in animal behaviour, methods of controlling climatic stress.

2.4 Semen quality : Preservation and Artificial Insemination-Components of semen, composition of spermatozoe, chemical and physical properties of ejaculated semen, factors affecting semen **in vivo** and **in vitro.** Factors affecting semen production and quality preservation, composition of diluents, sperm concentration, transport of diluted semen. Deep Freezing techniques in cows, sheep and goats, swine and poultry.

Detection of oestrus and time of insemination for better conception.

3. **Livestock Production and Management :** 3.1 Commercial Dairy Farming-Comparison of dairy farming in India with advanced countries. Dairying under fixed farming and as a specialised farming, economic dairy farming, Starting of a dairy farm. Capital and land requirement, organisation of the dairy farm.

Procurement of goods; opportunities in dairy farming, factors determining the efficiency of dairy animal, Herd recording, budgeting, cost of milk production; pricing policy; Personnel Management. Developing Practical and Economic ration for dairy cattle; supply of greens throughout the year, field and fodder requirements of Dairy Farm, Feeding regimes for day and young stock and bulls, heifers and breeding animals, new trends in feeding young and adult stock; Feeding records.

3.2. Commercial meat, egg and wool production: Development of practical and economic rations for sheep, goats, pigs, rabbits and poultry. Supply of greens, fodder, feeding regimens for young and mature stock. New trends in enhancing production and management. Capital and land requirements and socio-economic concept.

3.3. Feeding and management of animals under drought, flood and other natural calamities.

4. **Genetics and Animal Breeding :** Mitosis and Meiosis; Mendelian inheritance; deviations to Mendelian genetics; Expression of genes; Linkage and crossing over; Sex determination, sex influenced and sex limited characters; Blood groups and polymorphism; Chromosome aberrations; Gene and its structure; DNA as a genetic material; Genetic code and protein synthesis; Recombinant DNA technology, Mutations, types of mutations, methods for detecting mutations and mutation rate.

4.1 **Population Genetics Applied to Animal Breeding:** Quantitative Vs. qualitative traits; Hardy Weinberg Law; Population Vs. individual; Gene and genotypic frequency; Forces changing gene frequency; Random drift and small populations; Theory of path coefficient; Inbreeding, methods of estimating inbreeding coefficient, systems of inbreeding; Effective population size; Breeding value, estimation of breeding value, dominance and epistatic deviation; partitioning of variation; Genotype X environment correlation and genotype X environment interaction; Role of multiple measurements; Resemblance between relatives.

4.2 **Breeding Systems :** Heritability, repeatability and genetic and phenotypic correlations, their methods of estimation and precision of estimates; Aids to selection and their relative merits; Individual, pedigree, family and within family selection; Progeny testing; Methods of selection; Construction of selection indices and their uses; Comparative evaluation of genetic gains through various selection methods; Indirect selection and Correlated response; Inbreeding, upgrading, cross-breeding and synthesis of breeds; Crossing of inbred lines for commercial production; Selection for general and specific combining ability; Breeding for threshold character.

1. **Health and Hygiene**

1.1. **Histology and Histological Techniques :** Stains-Chemical classification of stains used in biological work-principles of staining tissues-mordants-progressive & regressive stains-differential staining of cytoplasmic and connective tissue elements-Methods of preparation and processing of tissues-celloidin embedding-Freezing microtomy-Microscopy-Bright field microscope and electron microscope. Cytology-structure of cell, organells & inclusions; cell division-cell types-Tissues and their classification-embryonic and adult tissues-Comparative histology of organs:-vascular, Nervous, digestive, respiratory, musculo-skeletal and urogenital systems-Endocrine glands-Integuments-sense organs.

1.2. **Embryology :** Embryology of vertebrates with special reference to aves and domestic mammals-gametogenesis-fertilization-germ layers-foetal membranes & placentation-types of placenta in domestic mammals-Teratology-twin & twinning-organogenesis-germ layer derivatives-endodermal, mesodermal and ectodermal derivatives.

1.3 **Bovine Anatomy-Regional Anatomy :** Paranasal sinuses of OX-surface anatomy of salivary glands. Regional anatomy of infraorbital, maxillary, mandibuloalveolar, mental & coronal nerve block-Regional anatomy of paravertebral nerves, pudental nerve, median, ulnar & radial nerves-tibial, fibular and digital

nerves-Cranial nerves-structures involved in epidural anaesthesia-superficial lymph nodes-surface anatomy of visceral organs of thoracic, abdominal and pelvic cavities-comparative features of locomotor apparatus & their application in the biomechanics of mammalian body.

1.4 **Anatomy of Fowls :** Musculo-skeletal system-functional anatomy in relation to respiration and flying, digestion and egg production.

1.5 **Physiology of blood and its circulation, respiration; excretion, Endocrine glands in health and disease.**

1.5.1 **Blood constituents :** Properties and functions-blood cell formation-Haemoglobin synthesis and chemistry-plasma proteins production, classification and properties; coagulation of blood; Haemorrhagic disorders-anticoagulants-blood groups-Blood volume-Plasma expanders-Buffer systems in blood. Biochemical tests and their significance in disease diagnosis.

1.5.2. **Circulation:** Physiology of heart, cardiac cycle-heart sounds, heartbeat, electrocardiograms, Work and efficiency of heart-effect of ions on heart function-metabolism of cardiac muscle, nervous and chemical regulation of heart, effect of temperature and stress on heart, blood pressure and hypertension, Osmotic regulation, arterial pulse, vasomotor regulation of circulation, shock. Coronary & pulmonary circulation, Blood-Brain barrier-Cerebrospinal fluid-circulation in birds.

1.5.3 **Respiration :** Mechanism of respiration, Transport and exchange of gases-neural control of respiration-chemoreceptors-hypoxia-respiration in birds.

1.5.4 **Excretion:** Structure and function of kidney-formation of urinemethods of studying renal function-renal regulation of acid-base balance; physiological constituents of urine-renal failure-passive venous congestion-Urinary recreation in chicken-Sweat glands and their function. Biochemical tests for urinary dysfunction.

1.5.5 **Endocrine glands :** Functional disorders, their symptoms and diagnosis. Synthesis of hormones, mechanism and control of secretion-hormonal receptors-classification and function.

1.6. **General knowledge of pharmacology and therapeutics of drugs :** Celluar level of pharmacodynamics and pharmaco-kinetics-Drugs acting on fluids and electrolyte balance-drugs acting on Autonomic nervous system-Modern concepts of anaesthesia and dissociative anaesthetics-Autocoids-Antimicrobials and principles of chemotherapy in microbial injections-use of hormones in therapeutics-chemotherapy of parasitic infections-Drug and economic persons in the Edible tissues of animals-chemotherapy of Neoplastic diseases.

1.7. **Veterinary Hygiene with reference to water, air and habitation :** Assessment of pollution of water, air and soil-Importance of climate in animal health-effect of environment on animal function and performance-relationship between industri-alisation and animal agriculture-animal housing requirements for specific categories of domestic animals viz. pregnant cows & sows, milking cows, broiler birds-stress, strain & productivity in relation to animal habitation.

2. **Animal Diseases :**

2.1 Pathogenesis, symptoms, postmortum lesions, diagnosis, and control of infection diseases of cattle, pigs and poultry, horses, sheep and goats.

2.2 Etiology, symptoms, diagnosis, treatment of production diseases of cattle, pig and poultry.

2.3 Deficiency diseases of domestic animals and birds.

2.4 Diagnosis and treatment of nonspecific condition like impaction, Bloat, Diarrhoea, Indigestion, dehydration, stroke, poisioning.

2.5 Diagnosis and treatment of neurological disorders.

2.6 Principles and methods of immunisation of animals against specific diseases-hard immunity-disease free zones-'zero' disease concept-chemoprophylaxis.

2.7 Anaesthesia-local, regional and general-preanaesthetic medication, Symptoms and surgical interference in fractures and dislocation, Hernia, choking, abomassal displacement-Caesarian operations, Rumenotomy-Castrations.

2.8 Disease investigation techniques-Materials for laboratory investigation-Establishment Animal Health Centres-Disease free zone.

3. **Veterinary Public Health**

3.1 **Zoonoses :** Classification, definition; role of animals and birds in prevalence and transmission of zoonotic diseases-occupational zoonotic diseases.

3.2. **Epidemiology :** Principles, definition of epidemiological terms, application of epidemiological measures in the study of diseases and disease control, Epidemiological features of air, water and food borne infections.

3.3 **Veterinary Jurisprudence :** Rules and Regulations for improvement of animal quality and prevention of animal diseases-state and control Rules for prevention of animal and animal product borne diseases-S.P. C.A.-veterolegal cases-certificates-Materials and Methods of collection of samples for veterolegal investigation.

4. **Milk and Milk Products Technology :**

4.1 **Milk Technology :** Organization of rural milk procurement, collection and transport of raw milk.

Quality, testing and grading raw milk, Quality storage grades of whole milk, Skimmed milk and cream.

Processing, packaging, storing, distributing, marketing defects and their control and nutritive properties of the following milks : Pasteurized, standardized, toned, double toned, sterilized, homogenized, reconstituted, recombined and flavoured milks. Preparation of cultured milks, cultures and their management, youghurt, Dahi, Lassi and Srikhand. Preparation of flavoured and sterlized milks. Legal standards, Sanitation requirement for clean and safe milk and for the milk plant equipment.

4.2 **Milk Products Technology :** Selection of raw materials, assembling, production, processing, storing, distributing and marketing milk products such as Butter, Ghee, Khoa, Channa, Cheese; Condensed, evaporated, dried milk and baby food; Ice cream and Kulfi; by products; whey products, butter milk, lactose and casein. Testing Grading, judging milk products-BIS and Agmark specifications, legal standards, quality control nutritive properties. Packaging, processing and operational control Costs.

5. Meat Hygiene and Technology :

5.1 Meat Hygiene :

5.1.1 Ante mortem care and management of food animals, stunning, slaughter and dressing operations; abattoir requirements and designs; Meat inspection procedures and judgement of carcass meat cuts-drading of carcass meat cuts-duties and functions of Veterinarians in Wholesome meat production.

5.1.2 Hygienic methods of handling production of meat-spoilage of meat and control measures-Post slaughter physicochemical changes in meat and factors that influence them-quality improvement methods-Adulteration of meat and defection-Regulatory provisions in Meat trade and Industry.

5.2. **Meat Technology**

5.2.1 Physical and chemical characteristics of meat-meat emulsions-methods of preservation of meat-curing, canning, irradiation, packaging of meat and meat products; meat products and formulations.

5.3. **Byproducts :** Slaughter house by products and their utilisation-Edible and inedible byproducts-social and economic implications of proper utilisation of slaughter house byproducts-Organ products for food and pharmaceuticals.

5.4. **Poultry Products Technology :** Chemical composition and nutritive value of poultry meat, pre slaughter care and management. Slaughtering techniques, inspection, preservation of poultry meat, and products. Legal and BIS standards.

Structure, composition and nutritive value of eggs. Microbial spoilage. Preservation and maintenance. Marketing of poultry meat, eggs and products.

5.5. **Rabbit/Fur Animal farming :** Care and management of rabbit meat production. Disposal and utilization of fur and wool and recycling of waste byproducts. Grading of wool.

6. **Extension :** Basic philosophy, objectives, concept and principles of extension. Different Methods adopted to educate farmers under rural conditions. Generation of technology, its transfer and feedback. Problems of constraints in transfer of technology. Animal husbandry programmes for rural development.

Anthropology – Optional

1.1 Meaning and scope Anthropology

1.2 Relationship with other disciplines: History, Economics, Sociology, Psychology, Political Science, Life Science, Medical Science.

1.3 Main branches of Anthropology, their scope and relevance

a) Social-cultural Anthropology

b) Physical and biological Anthropology

c) Archaeological Anthropology.

1.4 Human Evolution and emergence of Man.

Organic Evolution-Theories of evolution in historical perspective, pre-Darwinian, Darwinian and Post-Darwinian period. Modern synthetic theory of evolution; brief outline of terms and concepts of evolutionary biology (Doll's rule, Cope's rule, Gause's rule, parallelism, convergence, adaptive radiation, mosaic evolution); Principles of systematics and taxonomy, major primate taxa, tertiary and quaternary fossil primates, Systematics of Hominoidea and Hominidae, Origin and evolution of man-'*Homo erectus and Homo sapiens*'.

1.5 Phylogenetic status, characteristics and distribution of the following:

a) Prepleistocence fossil primates-*Oreopithecus.*

b) South and East African hominids-Plesianthropus/Australopithecus Africaus, Paranthropus, Australopithecus.

c) *Paranthropus-Homo erectus-Homo erectus javanicus, Homo erectus pekinensis*.

d) *Homo Heidelbergensis.*

e) Neanderthal man-La-chapelle-aus-saints (Classical type), Mt. Carmelites types (Progressive type).

f) Rhodesian man

g) Homo sapiens-Cromognon, Grimaldi, Chancelede.

Recent advances in understanding the evolution, distribution and multidisciplinary approach to understand a fossil type in relation to others.

1.6 Evolutionary trend and classification of the order Primates, Relationship with other mammals, molecular evolution of Primates, Comparative anatomy of man and apes, primate locomotion;-terrestrial and arboreal adaptation, skeletal changes due to erect posture and its implications.

1.7 Cultural Evolution-broad outlines of pre-historic cultures:

a) Paleolithic

b) Mesolithic

c) Neolithic

d) Chalcolithic

e) Copper-Bronze age

f) Iron age

2.1 Family-Definition and typology of family, household and domestic groups. Basic structure and functions; stability and changes in family. Typological and processual approaches to the study of family. Impact of urbanization, industrialization, education and feminist movements. Universality of family-a critique.

2.2 **Concept of kinship :** Definition of kin, incest prohibition exogamy and endogamy. Principles of descent-types and functions. Political and jural aspects of kinship. Unilineal, bilateral and double descent. Descent, filiation and complementary filiation. Kinship terminology, typology and approaches to the study of terminology Alliance and descent.

2.3 Marriage -Definition, types and variation of marriage systems. Debates on the universal definition of marriage. Regulation of marriage-preferential, prescriptive, proscriptive and open systems. Types and form of marriage Dowry, bride-price, pestation and marriage stability.

3.1 Study of culture, patterns and processes. Concept of culture, patterns of culture, relationships between culture and civilization and society.

3.2 Concept of Social Change and Cultural Change:

3.3 Social structure and social organization, Role-analysis and social network. Institutions, groups community. Social stratification: principles and form, status, class and power, gender. Nature and types of mobility.

3.4 Concept of Society.

3.5 Approaches to the study of culture and society-classical evolutionism, neo-evolutionism, culture ecology, historical particularism and diffusionism, structural-functionalism, culture and personality, transaction-alism, symbolism, congnitive approach and new ethnography, post structuralism and post-modernism.

4.1 Definitions and functions of religion. Anthropological approaches to the study of religion-evolutionary, psychological and functional. Magic, witchcraft and sorcery; definitions and functions and functionaries: priest, saman, medicine man and sorcerers. Symbolism in religion and rituals. Ethnomedicine. Myths and rituals: definitions and approaches to their study-structural, functional and processual Relation with economic and political structures.

5.1 Meaning, scope and relevance, principles governing production, distribution and consumption in communities subsisting on hunting-gathering, fishing, pastoralism, horticulture and other economic pursuits. Fomalist and substantivist debate-Dalton, Karl-polyanny and Marx approach and New Economic Anthropology. Exchange: gifts, barter, trade, ceremonial exchange and market economy.

5.2 Theoretical foundations. Types of political organisations-band, tribe, chiefdom, state, concept of power, authority and legitimacy. Social control, law and justice in tribal and peasant societies.

6.1 Concepts of developmental Anthropological perspective. Models of development. Critiques of classical developmental theories. Concepts of planning and planned development. Concept of participatory development. Culture ecology and sustainable development. Displacement and rehabilitation.

7.1 Concept of research in anthroplogy, subjectivity and reflexivity in terms of gender class, ideology and ethics. Distinction between methodology, methods and techniques. Nature and explanation in anthropological research. Positivistics and non-positivistic approaches. Comparative methods; nature, purpose and methods of comparison in social and cultural anthroplogy. Basic techniques of data collection. Interview, participant and other forms of observation, schedules, questionnaire, case-study methods, extended casestudy methods, life histories and seconday sources, oral history, genealogical method, participatory, learning and assessment (PLA). Participatory rapid assessment (PRA). Analysis, interpretation and presentation of data.

8.1 Concept, scope and major branches of human genetics. Its relationship with other branches of science and medicine.

8.2 Method for study of genetic principles in man-family study (pedegree analysis, twin study, foster child, co-twin method, cytogenetic method, chromosomal and karyotype analysis), biochemical methods, immunological methods, D.N.A. technology and recombinant technologies.

8.3 Twin study method-zygosity, heritability estimates, present status of the twin study method and its applications.

8.4 Mendelian genetics in man-family study, single factor, multifactor, lethal, sub-lethal, and polygenic inheritance in man.

8.5 Concept of genetic polymorphism and selection, Mendelian population, Hardy-Weinberg law; causes and changes which bring down frequency-mutation, isolation, migration, selection, inbreeding and genetic drift. Consanguineous and non-

consanguineous mating, genetic load, genetic effect of consanguineous and cousin marriages (statistical and probability methods for study of human genetics).

8.6 Chromosomes and chromosomal aberrations in man, methodology.

a) Numerical and structural aberrations (disorders)

b) Sex chromosomal aberrations-Klinefelter (XXY), Turner (XO), Super female (XXX), intersex, and other syndromic disorders.

c) Autosomal aberrations-Down syndrome, Patau, Edward and Cri-du-chat syndromes.

d) Genetic imprints in human disease, genetic screening, genetic counselling, human DNA profiling, gene mapping and genome study.

8.7 Concept of race in histrogical and biological perspective. Race and racism, biological basis of morphological variation of non-metric and metric characters. Racial criteria, racial traits in relation to heredity and environment; biological basis of racial classification, racial differentiation and race-crossing in man.

8.8 Ethnic groups of mankind-characteristics and distribution in world, racial classification of human groups. Principal living peoples of world. Their distribution and characterisicts.

8.9 Age, sex and population variation in gentic marker-ABO, Rh blood groups, HLA, Hp, transferrin, Gm, blood enzymes. Physiological characteristics-Hb level, body fat, pulse rate, respiratory functions and sensory perceptions in different cultural and socio-economic groups. Impact of smoking air pollutions, alcoholism, drugs and occupational hazards on health.

9.1 Concepts and Methods of Ecological Anthropology. Adaptation-social and cultural Deterministic theories-a critique. Resources-biological, non-biological and sustainable development. Biological adaptation-climatic, environmental, nutritional and genetic.

10.1 Relevance in understanding of contemporary society. Dynamics of ethnicity at rural, tribal, urban and international levels. Ethric conflicts and political developments. Concept of ethnic boundaries. Ethnicity and concept of nation state.

11.1 Concept of human growth and development-stages of growth-prenatal, natal, infant, childhood, adolescence, maturity, senescence.

Factors affecting growth and development genetic, environmental, biochemical, nutritional, cultural and socio-economic.

- Ageing and senescence. Theories and observations-biological and chronological longevity. Human physique and somatotypes. Methodologies for growth studies.

12.1 Reproductive biology, demography and population study. Reproductive physiology of male and female. Biological aspects of human fertility. Relevance of menarche, menopause and other bioevents to fertility. Fertily patterns and differentials.

12.2 Demographic theories-biological, social and cultural.

12.3 Demographic methods-census, registration system, sample methods, duel reporting system.

12.4 Population structures and population dynamics.

12.5 Demographic rates and ratios, life table-structure and utility.

12.6 Biological and socio-ecological factors influencing fecundity, fertility natality and mortality.

12.7 Methods of studying population growth.

12.8 Biological consequences of population control and family welfare.

13.1 Anthropology of sports

13.2 Nutritional Anthropology.

13.3 Anthropology in designing of defence and other equipments.

13.4 Forensic Anthropology.

13.5 Methods and principles of personal identification and reconstruction.

13.6 Applied human genetics-Paternity diagnosis genetic counselling and eugenics.

13.7 DNA technology-prevention and cure of diseases.

13.8 Anthropo-gentics in medicine

13.9 Serogenetics and cytogenetics in reproductive biology.

13.10 Application of statistical principles in human genetics and Physical Anthropology.

13.11 Evolution of the Indian Culture and Civilization-Pre historic (Paleolithic, Mesolithic and Neolithic), Protohistoric (Indus Civilization). Vedic and post-Vedic beginnings. Contributions of the tribal cultures.

13.12 Demographic profile of India-Ethinic and linguistic elements in the Indian population and their distribution. Indian population, factors influencing its structure and growth.

14.13. The basic structure and nature of traditional Indian social system-a critique. Varnasharam, Purushartha, Karma,
Rina and Rebirth. Theories on the origin of caste system, Jajmani system. Structural basis of inequality in traditional Indian society. Impact of Buddhism, Jainism, Islam and Christianity on Indian society.

15.14. Emergence, growth and development of anthropology in India-contributions of the 19th Century and early 20th Century scholar-administrators. Contributions of Indian anthropologists to tribal and caste studies. Contemporary nature of anthropological studies in India.

16.15. Approaches to the study of Indian society and culture-traditional and contemporary.

17.16 Aspects of Indian village-Social organisations of agriculture, impact of market economy on Indian villages.

18.17 Linguistic and religious minorities-social, political and economic status.

19.18 Tribal situation in India-biogenetic variability, linguistic and socio-economic characteristics of the tribal populations and their distribution. Problems of the tribal Communities-land alienation, poverty indebtedness, low literacy, poor educational facilities, unemployment, underemployment, health and nutrition. Developmental projects-tribal displacement and problems of rehabilitation:

Development of forest policy and tribals, Impact of urbanisation and industrialization on tribal and rural populations.

20.19. Problems of exploitation and deprivation of Scheduled Castes/Scheduled Tribes and Other Backward Classes. Constitutional safeguards for Scheduled Tribes and Scheduled Castes. Social change and contemporary tribal societies: Impact of modern democratic institutions, development programmes and welfare measures on tribals and weaker sections. Emergence of ethnicity, tribal movements and quest for identity. Pseudo-tribalism.

21.20. Social change among the tribes during colonial and post-Independent India.

22.21 Impact of Hinduism, Christianity, Islam and other religious on tribal societies.

23.22 Tribe and nation state-a comparative study of tribal communities in India and other countries.

24.23 History of administration of tribal areas, tribal policies, plans, programmes of tribal development and their implementation. Role of N.G.Os.

25.24 Role of anthropology in tribal and rural development.

26.25 Contributions of anthropology to the understanding of regionalism, communalism and ethnic and political movements.

BOTANY – Optional

1. Microbiology and Plant Pathology: Viruses, bacteria, and plasmids-structure and reproduction. General account of infection, Phytoimmunology. Applications of microbiology in agriculture, industry, medicine and pollution control in air, soil and water.

Important plant diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes. Mode of infection and dissemination. Molecular basis of infection and disease resistance/defence. Physiology of parasitism and control measures. Fungal toxins.

2. Cryptogams: Algae, Fungi, Bryophytes, Pteridophytes-structure and reproduction from evolutionary viewpoint. Distribution of Cryptogams in India and their economic potential.

3. Phanerogams: Gymnosperms: Concept of Progymonosperms. Classification and distribution of Gymnosperms. Salient features of Cycadales, Conferrals and Gnetales, their structures and reproduction. General account of Cycadofilicales, Bennettitales and Cordaitales.

Angiosperms: Systematics, anatomy, embryology, palynology and phylogeny.

Comparative account of various systems of Angiosperm Classiification. Study of angiospermic families–Magnoliaceae, Ranunculaceae, Brassicaceae (Cruci-ferae), Rosaceae, Leguminosae, Euphorbiaceae, Malvaceae, Dipterocar-paceae, Apiaceae (Umbelliferae), Asclepiadaceae, Verbenaceae, Solana-ceae, Rubiaceae, Cucurbitaceae, Asteraceae (Composite), Poaceae (Gramineae), Arecaceae (Palmae), Liliaceae, Musaceae, Orchidaceae.

Stomata and their types. Anomalous secondary growth, Anatomy of C 3 and C 4 plants.

Development of male and female gametophytes, pollination, fertilization. Endosperm–its development and function. Patterns of embryo development. Polymbryony, apoxmix, Applications of palynology.

4. Plant Utility and Exploitation:

Origin of cultivated plants, Vavilov's centres of origin. Plants as sources for food, fodder, fibres, spices, beverages, drugs, narcotics, insecticides, timber, gums, resins and dyes.

Latex, cellulose Starch and their products. Perfumery. Importance of Ethnobotany in Indian context. Energy plantation. Botanical Gardens and Herbaria.

5. Morphogenesis: Totipotency, polarity, symmetry and differentiation. Cell, tissue, organ and protoplast culture. Somatic hybrids and Cybrids.

6. Cell Biology: Techniques of Cell Biology. Prokaryotic and eukaryotic cells - structural and ultrastructural details. Structure and function of extracellular matrix or ECM (cell wall) and membranes-cell adhesion, membrane transport and vesicular transport. Structure and function of cell organelles (chloroplasts, mitochondria, ER, ribosomes, endosomes, lysosomes, peroxisomes, hydrogenosome). Nucleus, nucleolus, nuclear pore complex. Chromatin and nucleosome. Cell signalling and cell receptors. Signal transduction (G-1 proteins, etc.). Mitosis and meisdosis; molecular basis of cell cycle. Numerical and structural variations in chromosomes and their significance. Study of polytene, lampbrush and B-chromosomes–structure, behaviour and significance.

7. Genetics, Molecular Biology and Evolution: Development of genetics, and gene versus allele concepts (Pseudoalleles). Quantitative genetics and multiple factors. Linkage and crossing over–methods of gene mapping including molecular maps (idea of mapping function). Sex chromosomes and sexlinked inheritance, sex determination and molecular basis of sex differentiation. Mutation (biochemical and molecular basis). Cytoplasmic inheritance and cytoplasmic genes (including genetics of male sterility). Prions and prion hypothesis.

Structure and synthesis of nucleic acids and protines. Genetic code and regulation of gene expression. Multigene families.

Organic evolution-evidences, mechanism and theories. Role of RNA in origin and evolution.

8. Plant Breeding, Biotechnology and Biostatistics: Methods of plant breeding -- introduction, selection and hybridization (pedigree, backcross, mass selection, bulk method). Male sterility and heterosis breeding. Use of apomixis in plant breeding. Micropropagation and genetic engineering–methods of transfer of genes and transgenic crops; development and use of molecular markers in plant breeding.

Standard deviation and coefficient of variation (CV). Tests of significance (Z-test, t-test and chi-square tests). Probability and distributions (normal, binomial and Poisson distributions). Correlation and regression.

9. Physiology and Biochemistry: Water relations, Mineral nutrition and ion transport, mineral deficiencies. Photosynthesis–photochemical reactions, photophosphorylation and carbon pathways including C pathway (photorespiration), C, C and CAM pathways. Respiraion (anaerobic and aerobic, including fermentation–electron transport chain and oxidative phosphorylation. Chemiosmotic theory and ATP synthesis. Nitrogen fixation and nitrogen metabolism. Enzymes, coenzymes, energy transfer and energy conservation. Importance of secondary metabolites. Pigments as photoreceptors (plastidial pigments and phytochrome). Photoperiodism and flowering, vernalization, senescence. Growth substances-their chemical nature, role and applications in agri-horticulture, growth indices, growth

movements. Stress physiology (heat, water, salinity, metal). Fruit and seed physiology. Dormancy, storage and germination of seed. Fruit ripening -- its molecular basis and manipulation.

10. Ecology and Plant Geography: Ecological factors. Concepts and dynamics of community. Plant succession. Concepts of biosphere. Ecosystems and their conservation. Pollution and its control (including phytoremediaion).

Forest types of India -- afforestation, deforestation and social forestry. Endangered plants, endemism and Red Data Books. Biodiversity. Convention of Biological Diversity, Sovereign Rights and Intellectual Property Rights. Biogeochemical cells. Global warming.

CHEMISTRY – Optional

1. Atomic structure

Quantum theory, Heisenberg's uncertainity principle, Schrodinger wave equation (time independent). Interpretation of wave function, particle in one-dimensional box, quantum numbers, hydrogen atom wave functions. Shapes of s, p and d orbitals.

2. Chemical bonding

Ionic bond, characteristics of ionic compounds, factors affecting stability of ionic compounds, lattice energy, Born-Haber cycle; covalent bond and its general characteristics, polarities of bonds in molecules and their dipole moments. Valence bond theory, concept of resonance and resonance energy. Molecular orbital theory (LCAO method); bonding in homonuclear molecules: H_2^+, H_2 to Ne_2, NO, CO, HF, CN, CN^-, BeH_2 and CO_2. Comparison of valence bond and molecular oribtal theories, bond order, bond strength and bond length.

3. Solid State

Forms of solids, law of constancy of interfacial angles, crystal systems and crystal classes (crystallographic groups). Designation of crystal faces, lattice structures and unit cell. Laws of rational indices. Bragg's law. X-ray diffraction by crystals. Close packing, radious ratio rules, calculation of some limiting radius ratio values. Structures of NaCl, ZnS, CsCl, CaF_2, CdI_2 and rutile. Imperfections in crystals, stoichiometric and nonstoichiometric defects, impurity defects, semi-conductors. Elementary study of liquid crystals.

4. The gaseous state

Equation of state for real gases, intermolecular interactions, liquefictaion of gases and critical phenomena, Maxwell's distribution of speeds, intermolecular collisions, collisions on the wall and effusion.

5. Thermodynamics and statistical thermodynamics

Thermodynamic systems, states and processes, work, heat and internal energy; first law of thermodynamics, work done on the systems and heat absorbed in different types of processes; calorimetry, energy and enthalpy changes in various processes and their temperature dependence.

Second law of thermodynamics; entropy as a state function, entropy changes in various process, entropy–reversibility and irreversibility, Free energy functions; criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities; Nernst heat theorem and third law of thermodynamics.

Micro and macro states; canonical ensemble and canonical partition function; electronic, rotational and vibrational partition functions and thermodynamic quantities; chemical equilibrium in ideal gas reactions.

6. Phase equilibria and solutions

Phase equilibria in pure substances; Clausius-Clapeyron equation; phase diagram for a pure substance; phase equilibria in binary systems, partially miscible liquids–upper and lower critical solution temperatures; partial molar quantities, their significance and determination; excess thermodynamic functions and their determination.

7. Electrochemistry

Debye-Huckel theory of strong electrolytes and Debye-Huckel limiting Law for various equilibrium and transport properties.

Galvanic cells, concentration cells; electrochemical series, measurement of e.m.f. of cells and its applications fuel cells and batteries.

Processes at electrodes; double layer at the interface; rate of charge transfer, current density; overpotential; electroanalytical techniques–voltameter, polarography, ampero-metry, cyclic-voltametry, ion selective electrodes and their use.

8. Chemical kinetics

Concentration dependence of rate of reaction; defferential and integral rate equations for zeroth, first, second and fractional order reactions. Rate equations involving reverse, parallel, consecutive and chain reactions; effect of temperature and pressure on rate constant. Study of fast reactions by stop-flow and relaxation methods. Collisions and transition state theories.

9. Photochemistry

Absorption of light; decay of excited state by different routes; photochemical reactions between hydrogn and halogens and their quantum yields.

10. Surface phenomena and catalysis

Absorption from gases and solutions on solid adsorbents, adsorption isotherms,– Langmuir and B.E.T. isotherms; determination of surface area, characteristics and mechanism of reaction on heterogeneous catalysts.

11. Bio-inorganic chemistry

Metal ions in biological systems and their role in ion-transport across the membranes (molecular mechanism), ionophores, photosynthesis–PSI, PSII; nitrogen fixation, oxygen-uptake proteins, cytochromes and ferredoxins.

12. Coordination chemistry

(a) Electronic configurations; introduction to theories of bonding in transition metal complexes. Valence bond theory, crystal field theory and its modifications; applications of theories in the explanation of magnetism and electronic spactra of metal complexes.

(b) Isomerism in coordination compounds. IUPAC nomenclature of coordination compounds; stereochemistry of complexes with 4 and 6 coordination numbers; chelate effect and polynuclear complexes; trans effect and its theories; kinetics of substitution reactions in square-planer complexes; thermodynamic and kinetic stability of complexes.

(c) Synthesis and structures of metal carbonyls; carboxylate anions, carbonyl hydrides and metal nitrosyl compounds.

(d) Complexes with aromatic systems, synthesis, structure and bonding in metal olefin complexes, alkyne complexes and cyclopentadienyl complexes; coordinative unsaturation, oxidative addition reactions, insertion reactions, fluxional molecules and their characterization. Compounds with metal-metal bonds and metal atom clusters.

13. General chemistry of ‘f’ block elements

Lanthanides and actinides; separation, oxidation states, magnetic and spectral properties; lanthanide contraction.

14. Non-Aqueous Solvents

Reactions in liquid NH3, HF, SO2 and H2 SO4. Failure of solvent system concept, coordination model of non-aqueous solvents. Some highly acidic media, fluorosulphuric acid and super acids.

15. **Delocalised covalent bonding :** Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, kekulene, fulvenes, sydnones.

16(a) **Reaction mechanisms :** General methods (both kinetic and non-kinetic) of study of mechanism or organic reactions illustrated by examples–use of isotopes,

cross-over experiment, intermediate trapping, stereochemistry; energy diagrams of simple organic reactions–transition states and intermediates; energy of activation; thermodynamic control and kinetic control of reactions.

(b) **Reactive intermediates :** Generation, geometry, stability and reactions of carbonium and carbonium ions, carbanions, free radicals, carbenes, benzynes and niternes.

(c) **Substitution reactions :** S_N1, S_N2, S_Ni, SN1**/**, SN2**/**, SNi**/** and SRN1 mechanisms; neighbouring group participation; electrophilic and nucleophilic reactions of aromatic compound including simple heterocyclic compounds–pyrrole, furan thiophene, indole.

(d) **Elimination reactions :** E1, E2 and E1cb mechanism; orientation in E2 reactions–Saytzeff and Hoffmann; pyrolytic **syn** elimination–acetate pyrolysis, Chugaev and Cope eliminations.

(e) **Addition reactions : -** Electrophilic addition to C=C and C≡C; nucleophilic addition to C=O, C≡N, conjugated olefins and carbonyls.

(f) **Rearrangements :** Pinacol-pinacolune, Hoffmann, Beckmann, Baeyer–Villiger, Favorskii, Fries, Claisen, Cope, Stevens and Wagner-Meerwein rearrangements.

17. **Pericyclic reactions :** Classification and examples; Woodward-Hoffmann rules—clectrocyclic reactions, cycloaddition reactions [2+2 and 4+2] and sigmatropic shifts [1, 3; 3, 3 and 1, 5] FMO approach.

18. **Chemistry and mechanism of reactions :** Aldol condensation (including directed aldol condensation), Claisen condensation, Dieckmann, Perkin, Knoevenagel, Witting, Clemmensen, Wolff-Kishner, Cannizzaro and von Richter reactions; Stobbe, benzoin and acyloin condensations; Fischer indole synthesis, Skraup synthesis, Bischler-Napieralski, Sandmeyer, Reimer-Tiemann and Reformatsky reactions.

19. **Polymeric Systems**

(a) **Physical chemistry of polymers :** Polymer solutions and their thermodynamic properties; number and weight average molecular weights of polymers. Determination of molecular weights by sedimentation, light scattering, osmotic pressure, viscosity, end group analysis methods.

(b) **Preparation and properties of polymers :** Organic polymers–polyethylene, polystyrene, polyvinyl chloride, Teflon, nylon, terylene, synthetic and natural rubber. Inorganic polymers–phosphonitrilic halides, borazines, silicones and silicates.

(c) **Biopolymers :** Basic bonding in proteins, DNA and RNA.

20. **Synthetic uses of reagents :** OsO_4, HIO_4, CrO_3, $Pb(OAc)_4$, SeO_2, NBS, B_2H_6, Na-Liquid NH_3, $LiAlH_4$ $NaBH_4$ n-BuLi, MCPBA.

21. **Photochemist :** Photochemical reactions of simple organic compounds, excited and ground states, singlet and triplet states, Norrish-Type I and Type II reactions.

22. **Principles of spectroscopy and applications in structure elucidation**

(a) **Rotational spectra–**diatomic molecules; isotopic substitution and rotational constants.

(b) **Vibrational spectra–**diatomic molecules, linear triatomic molecules, specific frequencies of functional groups in polyatomic molecules.

(c) **Electronic spectra :** Singlet and triplet states. N–> π^* and $\pi \rightarrow \pi^*$ transitions; application to conjugated double bonds and conjugated carbonyls–Woodward-Fieser rules.

(d) **Nuclear magnetic resonance :** Isochronous and anisochronous protons; chemical shift and coupling constants; Application of H1 NMR to simple organic molecules.

(e) **Mass spectra :** Parent peak, base peak, daugther peak, metastable peak, fragmentation of simple organic cleavage, McLafferty rearrangement.molecules;

(f) **Electron spin resonance :** Inorganic complexes and free radicals.

Civil Engineering – Optional

Engineering Mechanics, Strength of Materials and Structural Analysis.

Engineering Mechanics :

Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane, moment of force and Varignon's theorem, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system.

First and Second Moment of area, Mass moment of Inertia.

Static Friction, Inclined Plane and bearings.

Kinematics and Kinetics :

Kinematics in Cartesian and Polar Co-ordinates, motion under uniform and nonuniform acceleration, motion under gravity. Kinetics of particle : Momentum and Energy principles, D' Alembert's Principle, Collision of elastic bodies, rotation of rigid bodies, simple harmonic motion, Flywheel.

Strength of Materials :

Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength, Leaf spring. Strain Energy in direct stress, bending & shear.

Deflection of beams : Mecaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Transmission of power, close coiled helical springs, Elastic stability of columns, Euler's Rankine's and Secant formulae. Principal Stresses and Strains in two dimensions, Mohr's Circle, Theories of Elastic Failure, Thin and Thick cylinder : Stresses due to internal and external pressure–Lame's equations.

Structural Analysis :

Castiglianio's theorems I and II, unit load method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution, Kani's method of analysis and column Analogy method applied to indeterminate beams and rigid frames.

Rolling loads and Influences lines : Influences lines for Shear Force and Bending moment at a section of beam. Criteria for maximum shear force and bending Moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses.

Arches : Three hinged, two hinged and fixed arches, rib shortening and temperature effects, influence lines in arches.

Matrix methods of analysis : Force method and displacement method of analysis of indeterminate beams and rigid frames.

Plastic Analysis of beams and frames : Theory of plastic bending, plastic analysis, statical method, Mechanism method.

Unsymmetrical bending : Moment of inertia, product of inertia, position of Neutral Axis and Principle axes, calculation of bending stresses.

Design of Structures : Steel, Concrete and Masonry Structures.

Structural Steel Design :

Structural Steel : Factors of safety and load factors. Rivetted, bolted and welded joints and connections. Design of tension and compression member, beams of built up section, rivetted and welded plate girders, gantry girders, stancheons with battens and lacings, slab and gussetted column bases.

Design of highway and railway bridges : Through and deck type plate girder, Warren girder, Pratt truss.

Design of Concrete and Masonry Structures :

Concept of mix design. Reinforced Concrete : Working Stress and Limit State method of design–Recommendations of I.S. codes Design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity, Isolated and combined footings.

Cantilever and Counterfort type retaining walls.

Water tanks : Design requirements for Rectangular and circular tanks resting on ground.

Prestressed concrete : Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

Design of brick masonry as per I.S. Codes

Design of masonry retaining walls.

Fluid Mechanics, Open Channel Flow and Hydraulic Machines

Fluid Mechanics : Fluid properties and their role in fluid motion, fluid statics including forces acting on plane and curve surfaces.

Kinematics and Dynamics of Fluid flow : Velocity and accelerations, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions, flownet, methods of drawing flownet, sources and sinks, flow separation, free and forced vortices.

Control volume equation, continuity, momentum, energy and moment of momentum equations from control volume equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, plane, curved, stationary and moving vanes, sluice gates, weirs, orifice meters and Venturi meters.

Dimensional Analysis and Similitude : Buckingham's Pi-theorem, dimensionless parameters, similitude theory, model laws, undistorted and distorted models.

Laminar Flow : Laminar flow between parallel, stationary and moving plates, flow through tube.

Boundary layer : Laminar and turbulent boundary layer on a flat plate, laminar sublayer, smooth and rough boundaries, drag and lift.

Turbulent flow through pipes : Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line, siphons, expansion and contractions in pipes, pipe networks, water hammer in pipes and surge tanks.

Open channel flow : Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, resistance equations and variation of roughness coefficient, rapidly varied flow, flow in contractions, flow at sudden drop, hydraulic jump and its applications surges and waves, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation, moving surges and hydraulic bore.

Hydraulic Machines and Hydropower :

Centrifugal pumps–Types, characteristics, Net Positive Suction Height (NPSH), specific speed. Pumps in parallel.

Reciprocating pumps, Airvessels, Hydraulic ram, efficiency parameters, Rotary and positive displacement pumps, diaphragm and jet pumps.

Hydraulic turbines, types classification, Choice of turbines, performance parameters, controls, characteristics, specific speed.

Principles of hydropower development. Type, layouts and Component works. Surge tanks, types and choice. Flow duration curves and dependable flow. Storage an pondage. Pumped storage plants. Special features of mini, micro-hydel plants.

Geo Technical Engineering

Types of soil, phase relationships, consistency limits particles size distribution, classifications of soil, structure and clay mineralogy.

Capillary water and structural water, effectives trees and pore water pressure, Darcy's Law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits.

Seepage pressure, quick sand condition, compressibility and consolidation, Terzaghi's theory of one dimensional consolidation, consolidation test.

Compaction of soil, field control of compaction. Total stress and effective stress parameters, pore pressure coefficients.

Shear strength of soils, Mohr Coulomb failure theory, Shear tests.

Earth pressure at rest, active and passive pressures, Rankine's theory, Coulomb's wedge theory, earth pressure on retaining wall, sheetpile walls, Braced excavation.

Bearing capacity, Terzaghi and other important theories, net and gross bearing pressure.

Immediate and consolidation settlement.

Stability of slope, Total Stress and Effective Stress methods, Conventional methods of slices, stability number.

Subsurface exploration, methods of boring, sampling, penetration tests, pressure meter tests.

Essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinessq's theory, Newmarks's chart, pressure bulb, contact pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from field tests, allowable bearing capacity, Settlement analysis, allowable settlement.

Proportioning of footing, isolated and combined footings, rafts, buoyancy rafts, Pile foundation, types of piles, pile capacity, static and dynamic analysis, design of pile groups, pile load test, settlement of piles, lateral capacity. Foundation for Bridges. Ground improvement techniques–preloading, sand drains, stone column, grouting, soil stabilisation.

Construction Technology, Equipment, Planning and Management

1. **Construction Technology :**

Engineering Materials :

Physical properties of construction materials : Stones, Bricks and Tiles; Lime, Cement and Surkhi Mortars; Lime Concrete and Cement Concrete, Properties of freshly mixed and hardened concrete, Flooring Tiles, use of ferro-cement, fibre-reinforced and polymer concrete, high strength concrete and light weight concrete. Timber : Properties and uses; defects in timber; seasoning and preservation of timber. Plastics, rubber and damp-proofing materials, termite proofing, Materials, for Low cost housing.

Construction :

Building components and their functions; Brick masonry : Bonds, jointing. Stone masonry. Design of Brick masonry walls as per I.S. codes, factors of safety, serviceability and strength requirements; plastering, pointing. Types of Floors & Roofs. Ventilators, Repairs in buildings.

Functional planning of building : Building orientation, circulation, grouping of areas, privacy concept and design of energy efficient building; provisions of National Building Code.

Building estimates and specifications; Cost of works; valuation.

2. **Construction Equipment :**

Standard and special types of equipment, Preventive maintenance and repair, factors affecting the selection of equipment, economical life, time and motion study, capital and maintenance cost.

Concreting equipments : Weigh batcher, mixer, vibration, batching plant, Concrete pump.

Earth-work equipment : Power shovel hoe, bulldozer, dumper, trailors, and tractors, rollers, sheep foot roller.

3. **Construction Planning and Management :** Construction activity, schedules, job layout, bar charts, organization of contracting firms, project control and supervision. Cost reduction measures.

Newwork analysis : CPM and PERT analysis, Float Times, cashing of activities, contraction of network for cost optimization, up dating, Cost analysis and resource allocation.

Elements of Engineering Economics, methods of appraisal, present worth, annual cost, benefit-cost, incremental analysis. Economy of scale and size. Choosing between alternatives including levels of investments. Project profitability.

Survey and Transportation Engineering

Survey : Common methods of distance and angle measurements, plane table survey, levelling traverse survey, triangulation survey, corrections, and adjustments, contouring, topographical map. Surveying instruments for above purposes. Techeometry. Circular and transition curves. Principles of photogrammetry.

Railways : Permanent way, sleepers, rail fastenings, ballast, points and crossings, design of turn outs, stations and yards, turntables, signals, and interlocking, level-crossing. Construction and maintenance of permanent ways : Superelevlation, creep of rail, ruling gradient, track resistance, tractive effort, relaying of track.

Highway Engineering : Principles of highway planning, Highway alignments. Geometrical design : Cross section, camber, superelevation, horizontal and vertical curves. Classification of roads : low cost roads, flexible pavements, rigid pavements. Design of pavements and their construction, evaluation of pavement failure and strengthening.

Drainage of roads : Surface and sub-surface drainage.

Traffic Engineering : Forecasting techniques, origin and destination survey, highway capacity. Channelised and unchannelised intersections, rotary design elements, markings, sign, signals, street lighting; Traffic surveys. Principle of highway financing.

Hydrology, Water Resources and Engineering :

Hydrology : Hydrological cycle, precipitation, evaporation, transpiration, depression storage, infiltration, overland flow, hydrograph, flood frequency analysis, flood estimation, flood routing through a reservoir, channel flow routing-Muskingam method.

Ground water flow : Specific yield, storage coefficient, coefficient of permeability, confined and unconfined equifers, aquifers, aquitards, radial flow into a well under confined and unconfined conditions, tube wells, pumping and recuperation tests, ground water potential.

Water Resources Engineering : Ground and surface water resource, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation, economics of water resources projects.

Irrigation Engineering : Water requirements of crops : consumptive use, quality of water for irrigation, duty and delta, irrigation methods and their efficiencies.

Canals : Distribution systems for canal irrigation, canal capacity, canal losses, alignment of main and distributory canals, most efficient section, lined canals, their design, regime theory, critical shear stress, bed load, local and suspended load transport, cost analysis of lined and unlied canals, drainage behind lining.

Water logging : causes and control, drainage system design, salinity.

Canal structures : Design of cross regulators, head regulators, canal falls, aqueducts, metering flumes and canal outlets.

Diversion head work : Principles and design of weirs of permeable and impermeable foundation, Khosla's theory, energy dissipation, stilling basin, sediment excluders.

Storage works : Types of dams, design, principles of rigid gravity and earth dams, stability analysis, foundation treatment, joints and galleries, control of seepage.

Spillways : Spillway types, crest gates, energy dissipation.

River training : Objectives of river training, methods of river training.

Environmental Engineering

Water Supply : Estimation of surface and subsurface water resources, predicting demand for water, impurities, of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water.

Intake of water : pumping and gravity schemes. Water treatment : principles of coagulation, flocculation and sedimentation; slow-; rapid-, pressure-, filters; chlorination, softening, removal of taste, odour and salinity.

Water storage and distribution : storage and balancing reservoirs : types, location and capacity. Distribution system : layout, hydraulics of pipe lines, pipe fittings, valves including check and pressure reducing valves, meters, analysis of distribution systems, leak detection, maintenance of distribution systems, pumping stations and their operations.

Sewerage systems : Domestic and industrial wastes, storm sewage–separate and combined systems, flow through sewers, design of sewers, sewer appurtenances, manholes, inlets, junctions, siphon. Plumbing in public buildings.

Sewage characterisation : BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal water course and on land.

Sewage treatment : Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of waste water.

Solid waste : collection and disposal in rural and urban contexts, management of long-term ill-effects.

Environmental pollution : Sustainable development. Radioactive wastes and disposal. Environmental impact assessment for thermal power plants, mines, river valley projects. Air pollution. Pollution control acts.

Commerce & Accountancy – Optional
Accounting & Finance

Accounting, Taxation & Auditing

Financial Accounting

Accounting as a financial information system; Impact of behavioural sciences.

Accounting Standards e.g., accounting for depreciation, inventories, gratuity, research and development costs, long term construction contracts, revenue recognition, fixed assets, contingencies, foreign exchange transactions, investments and government grants.

Advanced problems of company accounts.

Amalgamation absorption and reconstruction of companies.

Valuation of shares and goodwill.

Cost Accounting

Nature and functions of cost accounting.

Job Costing

Process Costing

Marginal Cositng; Techniques of segregating semi-variable costs into fixed and variable costs.

Cost-volume-profit relationship; aid to decision making including pricing decisions, shutdown etc.

Techniques of cost control and cost reduction.

Budgetary control, flexible budgets.

Standard costing and variance analysis.

Responsibility accounting, investment, profit and Cost centres.

Taxation

Definitions

Basis of charge.

Incomes which do not form part of total income.

Simple problems of computation of income under various heads, i.e., salaries, income from house property, profits and gains from business or profession, capital gains, income of other persons included in assessee's total income.

Aggregation of income and set off/carry forward of loss.

Deductions to be made in computing total income.

Auditing

Audit of cash transactions, expenses, incomes, purchases, sales.

Valuation and verification of assets with special reference to fixed assets, stocks and debts.

Verification of liabilities.

Audit of limited companies; appointment, removal, powers, duties and liabilities of company auditor, significance of 'true and fare', MAOCARO report.

Auditor's report and qualifications therein.

Special points in the audit of different organisations like clubs, hospitals, colleges, charitable societies.

Business Finance and Financial Institutions.

Finance Function-Nature, Scope and Objectives of Financial Management-Risk and Return relationship.

Financial Analysis as a Diagnostic Tool.

Management of Working Capital and its Components-Forecasting working capital needs, inventory, debtors, cash and credit management.

Investment Decisions-Nature and Scope of Capital Budgeting-Various types of decisions including Make or Buy and Lease or Buy-Techniques of Appraisal and their application-

Consideration of Risk and Uncertainty-Analysis of Non-financial Aspects.

Rate of Return on Investments-Required Rate of Return-its measurement-Cost of Capital-Weighted Average Cost-Different Weights.

Concepts of Valuation-Valuation of firm's Fixed Income Securities and Common Stocks.

Dividend and Retention Policy-Residual Theory or Dividend Policy-Other Models-Actual Practices.

Capital Structure-Leverages-Significance or Leverages-Theories of Capital Structure with special reference to Modigliani and Miller approach. Planning the Capital Structure of a Company; EBIT-EPS Analysis, Cash-flow ability to service debt, Capital Structure Ratios, other methods.

Raising finance-short term and long term. Bank finance-norms and conditions.

Financial Distress-Approaching BIFR under Sick Industrial Undertakings Act : Concept of Sickness, Potential Sickness, Cash Loss, Erosion of Networth.

Money Markets-the purpose of Money Markets, Money Market in India-Organization and working of Capital markets in India-Organization, Structure and Role of Financial Institutions in India. Banks and Investing Institutions-National and International Financial Institutions-their norms and types of financial assistance provided-inter-bank lending-its regulation, supervision and control. System of Consortium-Supervision and regulation of banks.

Monetary and Credit policy of Reserve Bank of India.

Organisation Theory and Industrial Relations
Organisation Theory

Nature and concept of Organisation-Organisation goals; Primary and secondary goals, Single and multiple goals, ends means chain-Displacement, succession,

expansion and multiplication of goals-Formal organisation; Type, Structure-Line and Staff, functional matrix, and project-Informal organisation-functions and limitations.

Evolution of organisation theory : Classical, Neo-classical and system approach-Bureaucracy; Nature and basis of power, sources of power, power structure and politics-Organisational behaviour as a dynamic system : technical, social and power systems-interrelations and interactions-Perception-Status system. Theoretical and empirical foundation of theories and Models of motivation. Morale and productivity-Leadership : Theories and styles-Management of conflicts in organisation-Transactional Analysis-Significance of culture to organisations. Limits of rationality-Organisational change, adaptation, growth and development, Professional management Vs. family management, Organisational control and effectiveness.

Industrial Relations.

Nature and scope of indsutrial relations, the socio-economic set-up, need for positive approach.

Industrial labour in India and its commitment-stages of commitments. Migratory nature-merits and shortcomings.

Theories of Unionism.

Trade Union movement in India-origin, growth and structure; Attitude and approach of management of India-recognition. Problems before Indian Trade Union movement.

Industrial disputes-sources; strikes and lockouts.

Compulsory adjudication and collective bargaining-approaches.

Worker's participation in management-philosophy, rationale; present day state of affairs and future prospects.

Prevention and settlement of industrial disputes in India.

Industrial relations in Public Enterprises.

Absenteeism and labour turnover in Indian Industries-causes

Relative wages and wage differentials; wage policy.

Wage policy in India; the Bonus issue.

I.L.O. and India;

Role of Personnel Department in the Organisation.

COMPUTER SCIENCE

1. **Formal Languages and Automata Theory**

Finite state machines, push down automata, Finite automata, context free language, context sensitive language, Turing machine, Decision question and undecided problems.

2. **Computer Organisation**

Functional components, CPU design, Memory organization and I/O organization.

3. **Operating Systems.**

Process mangagement, Memory management, File management I/O management.

4. **Software Engineering**

Life cycle model, function oriented design, object oriented design, User interface design, coding and Testing, software requirement, project management, software reliability and Maintenance.

5. **Date Structures**

Continuous and Non-continuous data structures, Dynamic storage allocations, File organization techniques.

6. **Principle of Programming Languages.**

Various programming paradigms Syntax, Semantics, Block structure, Scooping, Binding, Object oriented programming, Functional programming, Logic and concurrent programming.

7. **Database Management**

Concept, Data independence, Diffierent models, Storage organization, query languages, Normal forms, Decomposition, Security, concurrency, Recovery.

8. **Data communication and computer Networks**

Basics of digital communication, Network architecture, physical layer, Medium access protocols, Data-link layer, Network layer, Transport layer and Application layer.

Economics – Optional

1. Ricardian, Marshallian and Walrasain approaches to price determination. Types of Markets and price determination. Criteria or Welfare improvement. Alternate theories of distribution.

2. Functions of money-Measurement of price level changes-Money and real balances-Monetary standards-High-powered money and the Quantity theory of money, its variants and critiques thereof-Demand for and supply of money-The money multiplier. Theories of determination of interest rate-Interest and prices-Theories of inflation and control of inflation.

3. Full employment and Says' Law-underemployment equilibrium-Keynes' Theory of employment (and income) determination-Critiques of Keynesian Theory.

4. The modern monetary system-Banks, non-bank financial intermediaries, Discount House, and Central Bank. Structure of Money and financial markets and control. Money market instruments, bills and bonds. Real and nominal interest rates. Goals and instruments of monetary management in closed and open economies. Relation between the Central Bank and the Treasury. Proposal for ceiling on growth rate of money.

5. Public finance and its role in market economy in stabilisation, supply stability, allocative efficiency, distribution and development. Sources of revenue-Forms of Taxes and subsidies, their incidence and effects; Limits to taxation, loans, crowding-out effects, and limits to borrowing. Types of budget deficits-Public expenditure and its effects.

6. **International Economics**

(i) Old and New theories of International Trade.

a) Comparative advantage, Terms of trade and offer curve.

b) Product cycle and Strategic trade theories.

c) "Trade as an engine of growth" and theories of underdevelopment in an open economy.

(ii) Forms of protection.

(iii) Balance of Payments Adjustments Alternative Approaches.

a) Price versus income, income adjustments under fixed exchange rates.

b) Theories of policy mix.

c) Exchange rate adjustments under capital mobility.

d) Floating Rates and their implications for developing countries; Currency Boards.

(iv) (a) IMF and the World Bank.

(b) W.T.O.

(c) Trade Blocks and monetary unions.

7. **Growth and development.**

(i) Theories of growth : Classical and neo-classical theories; The Harrod model; economic development under surplus Labour; wage-goods as a constraint on growth; relative importance of physical and human capitals in growth; innovations and development; Productivity, its growth and source of changes thereof. Factors determining savings to income ratio and the capital-out put ratio.

(ii) Main features of growth : Changes in Sectoral compositions of income; Changes in occupational distribution; changes in income distribution; changes in consumption levels and patterns; changes in savings and investment and in pattern of investment. Case for and against industralization. Significance of agriculture in developing countries.

(iii) Relation between state, planning and growth, Changing roles of market and plans in growth economic policy and growth.

(iv) Role of foreign capital and technology in growth. The significance of multi-nationals.

(v) Welfare indicators and measures of growth-Human development indices-The basic needs approach.

(vi) Concept of sustainable development; convergence of levels of living of developed and developing countries; meaning of self-reliance in growth and development.

8. Evolution of the Indian Economy till independence. The Colonial Heritage : Land System & Agriculture, Taxes, Money and credit, Trade, Exchange Rate, the "Drain of Wealth controversy" of late 19th Century. Randade's critique of Laissez-Faire; Swadeshi movement; Gandhi and Hind Swaraj.

9. Indian Economics in Post-Independent Era-Contributions of Vakil, Gadgil and Rao. National and percapita Income; Patterns, Trends, Aggregate and sectoral-composition and changes therein. Broad factors determining National Income and its distribution; Measures of poverty. Trends in below poverty-line proportion.

10. Employment : Factors determining employment in short and long periods. Role of capital, wage-goods, wage-rate and technology. Measures of unemployment. Relation between income, poverty and employment, and issues of distribution and social justice.

Agriculture-Institutional set-up of land system size of agricultre holdings and efficiency-Green Revolution and technological changes-Agricultural prices and terms of trade-Role of public distribution and farm-subsidies on agricultural prices and production. Employment and poverty in agriculture-Rural wages-employment

schemes-growth experience-land reforms. Regional disparities in agricultural growth. Role of Agriculture in export.

11. Industry : Industrial system of India : Trends in Composition and growth. Role of public and private sectors, Role of small and cottage industries. Indian industrial Strategy-Capital versus consumer goods, wage-goods versus luxuries, capital-intensive versus labour-intensive techniques, import-substituting versus export promotion. Sickness and high-cost Industrial policies and their effects. Recent moves for liberalisation and their effects on Indian industry.

12. Money and banking : The monetary institutions of India: Factors determining demand for and supply of money. Sources of Reserve money-money multiplier-Techniques of money supply regulation under open economy. Functioning of money market in India. Budget deficit and money supply. Issues in Reform of Monetary and Banking Systems.

13. Index numbers of price levels-Course of Price level in post-Independence period-sources and causes of inflation-role of monetary and supply factors in price level determination-policies towards control of inflation. Effects of inflation under open economy.

14. Trade, balance of payments and exchange : Foreign trade of India; composition and direction shifts in trade policy from import substituion to export promotion. Impact of liberalisation on pattern of trade. India's external Borrowings-the Debt problem. Exchange rate of the rupee; Devaluations, depreciations and their effects on balance of payments-Gold imports and Gold policy-convertibility on current and capital accounts-rupee in an open economy. Integration of Indian economy with world economy-India and the WTO.

15. Public Finance and Fiscal Policy : Characteristics of and trends in India's Public Finance-Role of Taxes, (direct and indirect) and subsidies-Fiscal and monetary deficits-public expenditures and their significance-Public Finance and Inflation-Limiting Government's debt-Recent fiscal policies and their effects.

16. Economic Planning in India-Trends in Savings and investment-Trends in Savings to Income and capital-output ratios-Productivity, its sources, growth and trends-growth versus distribution-Transition from Central Planning to indicative planning-relation between Market and Plan-strategies for Growth, social justice and Plans. Planning and increasing the growth rate.

Education – Optional

1. Meaning, definition and scope of education. Aims – individual, social, liberal and vocational and Harmonious development of education, Aims of education in a democracy.

2. School and community – their relation, functions and responsibilities.

3. Curriculum, Definition and types of curricula, defects of present curriculum, principles of curriculum construction, Importance of correlation of studies. Co-curricular activities and their values in education.

4. Freedom and discipline – Importance of freedom in education, Free-discipline, relation between freedom and discipline, Discipline meaning types and its importance, Reward and punishment.

5. Teacher – Qualities of a teacher importance of his personality. Functions of school teacher. Matrial Education needed for teaching.

6. Theories of play – play methods in education.

7. Education for National integration and international understanding.

8. Psychology – is meaning, scope of definition, its importance in education, Methods of educational psychology.

9. Physical basis of mental life – Importance of sensation, perception and conception.

10. Adolescence – its significance and problems.

11. Emotions and instincts – their impotance in education, Importance of needs, drives and motives.

12. Learning – its meaning and importance, laws of learning, efficiency in learning.

13. Image and imagination, its importance in education.

14. Memory – meaning and types of memory, cause of forgetting, attension and its relation to interest.

15. Intelligence – its meaning and nature.

16. Statistics in education – Calculation of mean, medium and mode, standard deviation and quartile deviation, Coefficient of correlation by rank, difference method.

17. Charter Act of 1813.

18. Anglicist – classicist controversy Macculay's minute and Lord Bentinck's resolution of 1835.

19. Wood's Despatch of 1854 – its impact on Indian education.

20. Indian Education Commission of 1882 – primary and secondary education.

21. Lord Curzon's educational policy – Primary, Secondary and University education.

22. Gokhale's Bill on primary education - resolution of 1913.

23. Hartog committees report of 1929.

24. Wardha Scheme of Education 1937, its implementation in India.

25. Universalisation of Elementary Education (UEE) in Manipur under EGS & AIE and SSA.

26. Adult Education – Problems in the implementation of Adult Education Programme – Obejectives and aims of NAEP (now AEP).

Electrical Engineering – Optional

Electrical Circuits–Theory and Applications

Circuit componets; network graphs; KCL, KVL; circuit analysis methods : nodal analysis, mesh analysis; basic network theorems and applications; transient analysis : RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits and applications; coupled circuits and applications; balanced 3-phase circuits. Two-port networks, driving point and transfer functions; poles and zeros of network functions. Elements of networks synthesis. Filter-theory : design and applications. Active filters. Circuit simulation : Input formats; methods of education formulation; solution of equations; output formats; SPICE.

Signals & Systems

Representation of continuous–time and discrete-time signals & systems; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

E.M. Theory

Maxwell's equations, wave propagation in bounded media. Boundary conditions, reflaction and refraction of plane waves. Transmission line : Distributed parameter circuits, travelling and standing waves, impedance matching, Smith chart. Waveguides : parallel plane guide, TE, TM and TEM waves, rectangular and cylindrical wave guides, resonators. Planar transmission lines; stripline, microstripline.

Analog Electronics

Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET. Diode circuits : clipping, clamping, rectifier. Biasing and bias stability. FET amplifiers. Current mirror; Amplifiers : single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency-response of

amplifiers. OPAMP circuits. Filters; sinusoidal oscillators : criterion for oscillation; single-transistor and OPAMP configurations. Function generators and wave-shaping circuits. Power supplies.

Digital Electronics

Boolean algebra; minimisation of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits : arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits : latches and flip-flops, counters and shift-registers. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Logic implementation using programmable devices (ROM, PLA, FPGA).

Energy Conversion

Principles of electromechanical energy conversion : Torque and emf in rotating machines. DC machines : charateristics and performance analysis; starting and speed control of motors.

Transformers : principles of operation and analysis; regulation, efficiency; 3-phase transformers. 3-phase induction machines and synchronous machines : characteristics and preformance analysis; speed control. Special machines : Stepper motors, brushless dc motors, permanent magnet motors single-phase motors; FHP.

Power Electronics and Electric Drives :

Semiconductor power devices : diode, transistor, thyristor, triac, GTO and MOSFET– static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters : fully-controlled and half-controlled; principles of thyristor choppers and inverters; basic concepts of speed control of dc and ac motor drives applications of variable-speed drives.

Analog Communication

Random variables : continuous, discrete; probability, probability functions. Statististical averages; probability models; Random signals and noise : white noise, noise equivalent bandwidth; signal transmission with noise; signal to noise ratio. Linear CW modulation : Amplitude modulation : DSB, DSB-SC and SSB. Modulators and Demodulators; Phase and Frequency modulation : PM & FM signals; narrowband FM; generation & detection of FM and PM, Deemphasis, Preemphasis. CW modulation system : Superhetrodyne receivers, AM receivers, communication receivers, FM receivers, phase locked loop, SSB receiver Signal to noise ratio calculation for AM and FM receivers.

Microwaves and Antenna

Electromagnetic radiation, Propagation of waves : ground waves, sky wave, space wave, tropospheric scatter propagation. Extraterrestrial communications. Antenna : Various types, gain, resistance, band-width, beamwidth and polarization, effect of ground. Antenna coupling; high frequency antennas; microwave antennas; special

purpose antennas. Microwave Services : Klystron, magnetron, TWT, gun diodes, Impatt, Bipolar and FETs, Microwave integrated circuits. Microwave measurements.

Control Systems

Elements of control systems; block-diagram representation; open-loop & closed-loop systems; principles and applications of feed-back. LTI systems : time-domain and transform-domain analysis. Stability : Routh Hurwitz criterion, root-loci, Nyquist's criterion, Bode-plots, Design of lead-lad compensators. Proportional, PI, PID controllers. State-variable representation and analysis of control systems. Principles of discrete-control systems.

Electrical Engineering Materials

Electrical/electronic behaviour of materials : conductivity; free-electrons and band-theory; intrinsic and extrinsic semiconductor, p-n junction; solar cells, super-conductivity. Dielectric behaviour of materials; polarization phenomena; piezo-electric phenomena. Magnetic materials : behaviour and application. Photonic materials : refractive index, absorption and emission of light, optical fibres, lasers and opto-electronic materials.

Microprocessors and microcomputers

8-bit microprocessor : architecture, CPU, module design, memory interfacing, I/O, Peripheral controllers, Multiprocessing. IBM PC architecture : overview, introduction to DOS, Advanced microprocessors.

Measurement and Instrumentation

Error analysis; measurement of current voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency; bridge measurement. Electronic measuring instruments : multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyser, distortion-meter. Transducers : thermocouple, thermistor, LVDT, strain-guage, piezo-electric crystal. Use of transducers in measurements of non-electrical quantities. Data-acquisition systems.

IC Technology

Overview of IC Technology. Unit-steps used in IC fabrication : wafer cleaning, photo-lithography, wet and dry etching, oxidation, diffusion, ion-implantation, CVD and LPCVD techniques for deposition of poly-silicon, silicon, silicon-nitride and silicon di-oxide; metallisation and passivation.

Power Systems : Analysis and Control

Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer and distribution; per-unit quantities; bus admittance and impedance materices; load flow; voltage control and power factor correction; economic operation; symmeterical components, analysis of symmetrical and unsymmetrical faults. Concept of system stability : swing curves and equal area

criterion. Static VAR system. Basic concepts of HVDC transmission; FACTS. Computer control and Automation : Introduction to energy control centres; various states of a power system; SCADA systems and RTUs. Active power control : Speed control of generators, tie-line control, frequency control. Economic dispatch.

Power system protection

Principles of overcurrent, differential and distance protection. Concept of solid state relays. Circuit brakers. Computer aided protection : Introduction; line bus, generator, transformer protection; numeric relays and application of DSP to protection.

Non-conventional Energy Sources and Energy Management

Introduction to the energy problem; difficulties with conventional energy sources. Wind-Energy : Basics of Wind turbine aerodynamics; wind-energy conversion systems and their integration into electrical grid. Solar-Energy : Thermal conversion : photo-voltaic conversion. Wave-energy. Importance of Energy Management : Energy audit; energy economics : discount rate, payback period, internal rate of return, life cycle costing.

Digital Communication

Pulse code modulation (PCM), diferential pulse code modulation (DPCM), delta modulation (DM), Digital modulation and demodulation schemes : amplitude, phase and frequency keying schemes (ASK, PSK, FSK). Error control coding : error detection and correction, linear block codes, convolution codes. Information measure and source coding. Data networks, 7-layer architecture.

Satellite Communication, Radar and TV

Satellite Communincation : General overview and technical characteristics, earth station equipment, satellite link design, CNR of Satellite system. Radar : Basic principles, Pulsed systems : CW Doppler radar, FMCW radar, Phase array radars. Television Systems : Television systems and standards, Black-and White-and Colour-TV transmission and receiver systems.

Fibred Optic System

Multiplexing : Time division multiplexing, Frequency Division multiplexing. Optical properties of materials : Refractive index absorption and emission of light, optical fibres, lasers and optoelectronic materials Fibre optic links.

Geography – Optional

Principles of Geography

Physical Geography

i) **Geomorphology :** Factors controlling landform development; endogenetic and exogenetic forces; origin and evolution of the earth's crust; physical conditions of the earth's interior; geosynclines; continental drift; isostasy; sea-floor spreading; plate tectonics; mountain building; volcanicity; earthquakes; concepts of geomorphic cycles; landforms associated with fluvial, arid, glacial, coastal and karst cycle; groundwater; Applied Geomorphology.

ii) **Climatology :** Temperature and pressure belts of the world; heat budget of the earth; atmospheric circulation; planetary and local winds; monsoons and jet streams; air masses and fronts; temperate and tropical cyclones; types and distribution of precipitation; Koppen's and Thornthwaite's classification of world climate; hydrological cycle; climatic change.

iii) **Oceanography :** Bottom topography of the Atlantic, Indian and Pacific Oceans; temperature and salinity of the oceans; ocean deposits; ocean currents and tides; marine resources–biotic, mineral and energy resources; coral reefs; sea-level changes.

iv) **Biogeography :** Genesis of soils; classification and distribution of soils; soil profile; soil erosion and conservation; factors influencing world distribution of plants and animals; problems of deforestation and conservation measures; social forestry, agro-forestry.

v) **Environmental Geography :** Human ecological adaptations; transformation of nature by man; environmental degradation and conservawtin; ecosystems and their management; global ecological imbalances–problems of pollution, global warming, reduction in bio-diversity and depletion of forests.

Human Geography

i) **Perspectives in Human Geography :** A real differentiation; regional synthesis; dichotomy and dualism; environmentalism; quantitative revolution and locational analysis; radical, behavioural, human and welfare approaches; cultural regions of the world human and welfare approaches; cultural regions of the world; human development indicators.

ii) **Economic Geography :** World economic develpment–measurement and problems; world resources and their distribution; energy crisis; the limits to growth; world agriculture–typology of agricultural regions; agricultural inputs and productivity; food and nutrition problems; famine–causes, effects and remedies; world industries–location patterns and problems; patterns of world trade.

iii) **Population and Settlement Geography :** Growth and distribution of world population; demographic atrributes; causes and consequencies of migration; concepts of over–, under– and optimum population; world population problems.

Types and patterns of rural settlements; hierarchy of urban settlements; concept of primate city and rank-size rule; functional classificatipn of towns; sphere of urban influence; rural-urban fringe; satellite town; problems of urbanisation.

iv) **Regional Planning :** Concept of a region; types of regions and methods of regionalisation; growth centres and growth poles; regional imbalances; environmental issues in regional planning; planning for sustainable development.

v) **Models, Theories and Laws in Human Geography :** System analysis in Human Geography; Malthusian, Marxian and Demographic Transition models; Central Place theories of Christaller and Losch; Von Thunen's model of agricultural location; Weber's model of industrial location; Rostov's model of stages of growth. Heart-land and Rimland theories; laws of international boundaries and frontiers.

Note : Candidates will be required to answer one compulsory map question pertinent to subjects covered by this paper.

Geography of India

i) **Physical Setting :** Space relationship of India with neighbouring countries; structure and relief; drainage system and watersheds; physiographic regions; mechanism of Indian monsoons; tropical cyclones and western distrubances; floods and droughts; climatic regions; natural vegetation, soil types and their distributions.

ii) **Resources :** Land, surface and groundwater, energy, minerals, and biotic resources, their distribution, utilisation and conservation; energy crisis.

iii) **Agriculture :** Infrastructure–irrigation, seeds, fertilizers, power; institutional factors–land holdings, land tenure and land reforms; agricultural productivity, agricultural intensity, crop combination, land capability; agro-and social forestry; green revolution and its socio-economic and ecological implications; significance of dry farming; livestock resources and white revolution; blue revolution; agricultural regionalisation; agro-climatic zones.

iv) **Industry :** Evolution of industries; locational factors of cotton, jute, iron and steel, fertiliser, paper, drugs and pharmaceutical, automobile and cottage indusries; industrial complexes and industrial regionalisaiton; new industrial policy; multinationals and liberalisation.

v) **Transport, Communication and Trade :** Road, railway, waterway, airway and pipeline networks and their complementary roles in regional development; growing importance of ports on national and foreign trade, trade balance; free trade and

export promotion zones; developments in communication technology and its impact on economy and society.

i) **Cultural Setting :** Racial and ethnic diversities; major tribes, tribal areas and their problems; role of langague, religion and tradition in the formation of cultural regions; growth, distribution and density of population; demographic attributes–sex-ratio, age structure, literacy rate, work-force, dependency ratio and longevity; migration (inter-regional, intra-regional and international) and associated problems, population problems and policies.

ii) **Settlements :** Types, patterns and morphology of rural settlements; urban development; census definition of urban areas; morphology of Indian cities; functional classification of Indian cities; conurbations and metropolitan regions; urban sprawl; slums and associated problems; town planning; problems of urbanisaiton.

iii) **Regional Development and Planning:** Experience of regional planning in India; Five Year Plans; integrated rural development programmes; panchayati raj and decentralised planning; command area development; watershed management; planning for backward area, desert drought-prone, hill and tribal area development; multi-level planning; geography and regional planning.

iv) **Political Aspects :** Geographical basis of Indian federalism; state reorganisation; regional consciousness and national integration; international boundary of India and related issues; disputes on sharing of water resources; India and geopolitics of the Indian Ocean.

v) **Contemporary Issues :** Environmental hazards–landslides, earthquakes, floods and droughts, epidemics; issues related to environmental pollution; changes in patterns of land use; principles of environmental impact assessment and environmental management; population explosion and food security; environmental degradation; problems of agrarian and industrial unrest; regional disparities in economic development; concept of sustainable growth and development.

Note : Candidates will be required to answer one compulsory map question pertinent to subjects covered by this paper.

GEOLOGY – Optional

(i) General Geology

The Solar System, meteorities, origin and interior of the earth. Radioactivity and age of earth; Volcanoes- causes and products, volcanic belts. Earthquakes-causes, effects, earthquake belts, seismicity of India, intensity and magnitude, seismongraphs. Island arcs, deep sea trenches and mid-ocean ridges. Continental drift-evidences and mechanics; seafloor spreading, plate tectonics. Isostasy, orogeny and epeirogeny. Continents and oceans.

(ii) Geomorphology and Remote Sensing

Basic concepts of geomorphology. Weathering and mass wasting. Landforms, slopes and drainage. Geomorphic cycles and their interpretation. Morphology and its relation to structures and lithology. Applications of geomorphology in mineral prospecting, civil engineering,. hydrology and environmental studies. Geomorphology of Indian subcontinent.

Aerial photographs and their interpretation-mertis and limitations. The Electronmagnetic Spectrum. Orbiting satellites and sensor systems. Indian Remote Sensing Sataellites. Satellites data products. Applications of remote sensing in geology. The Geographic Information System and its applications. Global Positioning System.

(iii) **Structural geology**

Principles of geologic mapping and map reading, projection diagrams, stress and strain ellipsoid and stress-strain relationships of elastic, plastic and viscous materials. Strain markers in deformed rocks. Behaviour of minerals and rocks under deformation conditions. Folds and faults classification and mechanics. Structural analysis of folds, foliations, lineations, joints and faults, unconformities. Superposed deformation. Time-relationship between crystallization and deformation. Introduction to petrofabrics.

(iv) **Paleontology**

Species- definition and nomenclature. Megafossils and Microfossils. Modes of preservation of fossils. Different kinds of microfossils. Application of microfossils in correlation, petroleum exploration, paleoclimatic and paleoceanographic studies. Morphology, geological history and evolutionary trend in Cephalopoda, Trilobita, Brachiopoda, Echinoidea and Anthozoa. Stratigraphic utility of Ammonoidea, Trilobita and Graptoloidea. Evolutionary trend in Hominidae, Equidae and Proboscidae. Siwalik fauna. Gondwana flora and its importance.

(v) **Stratigraphy and Geology of India**

Classification of stratigraphic sequences: lithostratigraphic, biostratigraphic, chronostratigraphic and magnetostratigraphic and their interrelationships. Distribution and classification of Precambrian rocks of India. Study of stratigraphic distribution and lithology of Phanerozoic rocks of India with reference to fauna, flora and economic importance. Major boundary problems- Cambrian/Precambrian, Permian/Triassic, Cretaceous/Tertiary and Pliocene/Pleistocene. Study of climatic conditions, paleogeography and igneous activity in the Indian subcontinent in the geological past. Tectonic framework of India. Evolution of the Himalayas.

(vi) **Hydrogeology and Engineering Geology :** Hydrologic cycle and genetic classification of water. Movement of subsruface water. Springs. Porosity, permeability, hydraulic conductivity, transmissivity and storage coefficient, classification of aquifers. Water-bearing characteristics of rocks. Groundwater chemistry. Salt water intrusion. Types of wells. Drainage basin morphometry. Exploration for groundwater. Groundwater recharge. Problems and management of groundwater. Rainwater harvesting. Engineering properties of rocks. Geological

investigations for dams, tunnels and bridges. Rock as construction material. Alkali-aggregate reaction. Landslides-causes, prevention and rehabilitation. Earthquake-resistant structures.

(vii) **Mineralogy**

Classification of crystals into systems and classes of symmetry. International system of crystallographic notation. Use of projection diagrams to represent crystal symmetry. Crystal defects. Elements of X-ray crystallography.

Petrological microscope and accessories. Optical properties of common rock forming minerals. Pleochroism, extinction angle, double refraction, birefringence, twinning and dispersion in minerals.

Physical and chemical characters of rock forming slilicate mineral groups. Structural classification of silicates. Common minerals of igneous and metamorphic rocks. Minerals of the carbonate, phosphate, sulphide and halide groups.

(viii) **Igneous ad Metamorphic Petrology**

Generation and crystallisation of magma. Crystallisation of albite-anorthite, diopside-anorthite and diopside-wollastonite-silica systems. Reaction principle., Magmatic differentation and assimilation. Petrogenetic significance of the textures and structrues of igneous rocks. Petrography and petrogenesis of granite, syenite, diorite, basic and ultrabasic groups, charnockite, anorthosite and alkaline rocks. Carbonatites. Deccan volcanic province.

Types and agents of metamporphism. Metamporphic grdes and zones. Phase rule. Facies of regional and contact metamorphism. ACF and AKF diagrams. Textures and structures of metamporphic rocks. Metamorphism of arenaceous, argillaceous and basic rocks. Minerals assemblages Retrograde metamorphism. Metasomatism and granitisation, migmatites, Granulite terrains of India.

(ix) **Sedimentology**

Sedimentary rocks: Processes of formation. diagenesis and lithification. Properties of sediments. Clastic and non-clastic rocks-their classification, petrography and depositional environment. Sedimentary facies and provenance. Sedimentary structures and their significance. Heavy minerals and their significance. Sedminetary basins of India.

(x) **Economic Geology**

Ore, ore minerals and gangue, tenor of ore, classification of ore deposits. Process of formation of minerals deposits. Controls of ore localisation. Ore textures and structures. Metallogenic epochs and provinces. Geology of the important Indian deposits of aluminium, chromium, copper, gold, iron, lead zinc, manganese, titanium, uranium and thorium and industrial minerals. Deposits of coal and petroleum in India. National Mineral Policy. Conservation and utilization of mineral resources. Marine mineral resources and Law of Sea.

(xi) **Mining Geology**

Methods of prospecting-geological, geophysical, geochemical and geobotanical. Techniques of sampling. Estimation of reserves or ore. Mehtods of exploration and mining metallic ores, industrial minerals and marine mineral resources. Mineral beneficiation and ore dressing.

(xii) **Geochemistry and Environmental Geology**

Cosmic abundance of elements. Composition of the planets and meteorites. Structure and compostion of earth and distribution of elements. Trace elements. Elements of crystal chemistry-types of chemical bonds, coordination number. Isolmorphism and polymorphism. Elementary thermodynamics.

Natural hazards-floods, landslides, coastal erosion, earthquakes and volcanic activity and mitigation. Environmental impact of urbanization, open cast mining, industrial and radioactive waste disposal, use of fertilizers, dumping of mine waste and fly-ash. Pollution of ground and surface water, marine pollution Environment protection-legislative measures in India.

History – Optional

1. Sources and approaches to study of early Indian history.

2. Early pastoral and agricultural communities. The archaeological evidence.

3. The Indus Civilization: its origins, nature and decline.

4. Patterns of settlement, economy, social organization and religion in India (c. 2000 to 500 B.C.) : archaeological perspectives.

5. Evolution of north Indian society and culture: evidence of Vedic texts (Samhitas to Sutras).

6. Teachings of Mahavira and Buddha. Contemporary society. Early phase of state formation and urbanization.

7. Rise of Magadha; the Mauryan empire. Ashoka's inscriptions; **his dhamma.** Nature of the Mauryan state.

8-9 Post-Mauryan period in northern and peninsular India: Political and administrative history,. Society, economy, culture and religion. Tamilaham and its society: the Sangam texts.

10-11 India in the Gupta and post-Gupta period (to c. 750) : Political histroy of northern and peninsular India; **Samanta** system and changes in political structure; economy; social structure; culture; religion.

12. Themes in early Indian cultural history: languages and texts; major stages in the evolution of art and architecture; major philosophical thinkers and schools; ideas in science and mathematics.

13. India, 750-1200 : Polity, society and economy. Major dynasties and political structurs in North India. Agrarian structures. " Indian feudalism". Rise of Rajputs. The Imperial Cholas and their contemporaries in Peninsular India. Villagle communities in the South. Conditions fof women. Commerce mercantile groups and guilds; towns. Problem of coinage. Arab conquest of Sind; the Ghaznavide empire.

14. India, 750-1200: Culture, Literature, Kalhana, historian. Styles of temple architecture; sculpture. Religious thought and institutions: Sankaracharya's vedanta. Ramanuja. Growth of Bhakti, Islam and its arrival in India. Sufism. Indian science. Alberuni and his study of Indian science and civilization.

15. The 13th Century. The Ghorian invasions. Factors behind Ghorian success. Economic, social and cultural consequences. Foundation of Delhi Sultanate. The "slave" Dynasty. IItutmish; Balban. "The Khalji Revolution". Early Sultanate architecture.

16. The 14th Century. Alauddin Khalji's conquests, agrarian and economic measures. Muhammad Tughluq's major "projects". Firuz Tughluq's concessions and public works. Decline of the Sultante. Foreing contacts: Ibn Battuta.

17. Economy societyand culture in the 13th and 14th centureis. Caste and slavery under sultanate. Tehnological changes. Sultanate architecture. [persian literature: Amir Khusrau, Historiography; Ziya Barani. Evolution of a composite culture. Sufism in North India. Lingayats. Bhakti schools in the south.

18. The 15th and early16th Century (Political History). Rise of Provincial Dynasties: Bengal, Kashmir (Zainul Abedin), Gujarat, Malwa, Bahmanids. The Vijayanagra Empire. Lodis. Mughal Empire, First phase : Babur, Humayun. The Sur Empire : Sher Shah's administration. The Portuguese colonial enterprise.

19. The 15th and early 16th Century (society, economy and culture). Regional cultures and literatures. provincial architectural styles. Society, culture, literature and the arts in Vijayanagara Empire.

Monotheistic movements: Kabir and Guru Nank. Bhakti Movements: Chaitanya. Sufism in its pantheistic phase.

20. Akbar: His conquests and consolidation of empire. Establishment of **jagir** and **mansab** systems. His Rajput policy. Evolution of religious and social outlook. Theory of **Sulh-i-kul** and religious policy. Abul Fazl, thinker and historian. Court patronage of art and technology.

21. Mughal empire in the 17th Century. Major policies (administrative and religious) of Jahangir, Shahjahan and Aurangzeb. The Empire and the Zamindars. Nature of the Mughal state. Late 17th Century crisis: Revolts. The Ahom kingdom, Shivaji and the early maratha kingdom.

22. Economy and society, 16th and 17th Centuries. Population. Agricultural and craft production. Towns, commerce with Europe through Dutch, English and French companies- a "trade revolution". Indian mercantile classes. Banking, insurance and credit systems. Conditions of peasants, famines. Condition of Women.

23. Culture during Mughal Empire. Persian literature (including historical works). Hindi and relgious literatures. Mughal architecture. Mughal painting. Provincial schools of architecture and painting. Classical music. Science and technology. Sawai Jai Singh, astronomer. Mystic eclecticism : Dara Shukoh. Vaishnav **Bhakti.** Mahrasthra Dharma. Evolution of the Sikh community (Khalsa).

24. First half of 18th Century: Factors behind decline of the Mughal Empire. The regional principalities (Nizam's Deccan, Bengal, Awadh). Rise of Maratha ascendancy under the Peshwas. The Maratha fiscal and financial system. Emergency of Afghan Power. Panipat, 1761. Internal weakness, political cultural and economic, on eve of the British conquest.

25. Establishment of British rule in India: Factors behind British success against Indian powers-Mysore, Maratha Con federacy and the Punjab as major powers in resistance; Policy of subsidiary Alliance and Doctrine of Lapse.

26. Colonial Economy : Tribute system. Drain of wealth and "deindustrialisation", Fiscal pressures and revenue settlements (Zamindari, Ryotwari and Mahalwari settlements); Structure of the British raj up to 1857 (including the Acts of 1773 and 1784 and administrative organisation).

27. Resistance to colonia rule : Early uprisings; Causes, nature and impact of the Revolt of 1857; Reorganisation of the Raj, 1858 and after.

28. Socio-cultural impact of colonial rule: Official social reform measures (1828-57); Orientalist-Anglicist controversy; coming of English education and the press; Christian missionary activities;Bengal Renaissance; Social and religious reform movements in Bengal and other areas; Women as focus of social reform.

29. Economy 1858-1914: Railways; Commercialisation of Indian agriculture; Growth of landless labourers and rural indebtedness; Famines; India as market for British industry; Customs removal, exchange and countervailing excise; Limited growth of modern industry.

30. Early Indian Nationalism: Social background; Formation of national associations; Peasant and tribal uprising during the early nationalist era; Foundation of the Indian National Congress; The Moderate phase of the Congress; Growth of Extremism; The

Indian Council Act of 1909; Home Rule Movement; The Government of India Act of 1919.

31. Inter-War economy of India: Industries and problem of Protection; Agricultural distress; the Great Depression; Ottawa agreements and Discriminatory Protection; the growth of trade unions; The Kisan Movement; The economic programme of the Congress' Karachi resolution, 1931.

32. Nationalism under Gandhi's leadership: Gandhi's career, thought and methods of mass mobilisation; Rowlatt Satyagraha, Khilafat- Non Cooperation Movement, Civil Disobedience Movement, 1940 Satyagraha and Quit India Movement; State People's Movement.

33. Other strands of the National Movement:

a) Revolutionary movements since 1905; (b) Constitutional politics; Swarajists, Liberals, Responsive Cooperation; (c) Ideas of Jawharlal Nehru, (d) The Left (Socialists and Communists); (e) Subhas Chandra Bose and the Indian National Army; (f) Communal strands: Muslim League and Hindu Mahasabha; (g) Women in the National Movement.

34. Literary and cultural lmovements: Tagore, Premchand, Subramanyam Bharati, Iqbal as examples only; New trends in art; Film industry; Writers' Organisations and Theatre Associations.

35. Towards Freedom: The Act of 1935; Congress Ministries, 1937-1939; The Pakistan Movement; Post-1945 upsurge (RIN Mutiny, Telangana uprising etc.,); Consititutional negotiations and the Transfer of Power, 15 August 1947.

36. First phase of Independence (1947-64): Facing the consequences of Partition; Gandhiji's murder; economic dislocation; Integration of States; The democratic constitution, 1950; Agrarian reforms; Building an industrial welfare state; Planning and industrialisation; Foreign policy of Non-alignment; Relations with neighbours.

37. **Enlightenment and Modern ideas**

I. Renaissance Background

II. Major Ideas of Enlightenment: Kant, Rousseau

III. Spread of Enlightenment outside Europe

IV. Rise of socialist ideas (to Marx)

38. **Origins of Modern Politics**

I. European States System

II. American Revolution and the Constitution.

III. French revolution and after math, 1789-1815.

IV. British Democratic Politics, 1815-1850; Parliamentary Reformers, Free Traders, chartists.

39. **Industrialization**

I. English Industrial Revolution: Causes and Impact on Society

II. Industrialization in other countries: USA, Germany, Russia, Japan

III. Socialist Industrialization: Soviet and Chinese.

40. **Nation-State System**

I. Rise of Nationalism in 19th century

II. Nationalism : state-building in Germany and Italy

III. Disintegration of Empires through the emergence of nationalities.

41. **Imperialism and Colonialism**

I. Colonial System (Exploitation of New World, Trans-Atlantic Slave Trade, Tribute from Asian Conquests)

II. Types of Empire: of settlement and non-settlement: Latin America, South Africa, Indonesia, Australia.

III. Imperialism and Free Trade: The New Imperialism

42. **Revolution and Counter-Revolution**

I. 19th Century European revolutions

II. The Russian Revolution of 1917-1921

III. Fascist Counter-Revolution, Italy and Germany.

IV. The Chinese Revolution of 1949

43. **World Wars**

I. 1st and 2nd World Wars as Total Wars: Societal Implications

II. World War I : Causes and Consequences

III. World War II : Political Consequence

44. **Cold War**

I. Emergence of Two Blocs

II. Integration of West Europe and US Strategy; Communist East Europe

III. Emergence of Third World and Non-Alignment

IV. UN and Dispute Resolution

45. **Colonial Liberation**

I. Latin America-Bolivar

II. Arab World-Egypt

III. Africa-Apartheid to Democracy

IV. South-East Asia-Vietnam

46. **Decolonization and Underdevelopment**

I. Decolonization: Break up of colonial Empires: British, French, Dutch

II. Factors constraining Development : Latin America, Africa

47. **Unification of Europe**

I. Post War Foundations : NATO and European Community

II. Consolidation and Expansion of European Community/European Union.

48. **Soviet Disintegration and the Unipolar World**

I. Factors in the collapse of Soviet communism and the Soviet Union, 1985-1991

II. Political Changes in East Europe 1989-1992

III. End of the Cold War and US Ascendancy in the World

IV. Globalization**.**

LAW – Optional

Constitutional Law of India

1. Nature of the Indian Constitution : the distinctive features of its federal character.

2. Fundamental Rights.

3. Relationship between Fundamental Rights, Directive Principles and Fundamental Duties.

4. Constitutional Position of the President and relation with the Council of Ministers.

5. Governor and his Powers.

6. Appointment and Transfer of Judges of the Supreme Court and the High Courts.

7. Supreme Court and High Courts: Powers and Jurisdiction.

8. Union Public Service Commission and State Public Service Commissions: Powers and Functions.

9. Distribution of Legislative Powers between the Union and the States.

10. Administrative Relationship between Union and the States.

11. Emergency Provisions

12. Civil Servants: Constitutional safeguards.

13. Parliamentary Privileges

14. Amendment of the Constitution.

15. Princople of Natural Justice

16. Delegated Legislation: Its constitutionality and judicial and legislative controls.

17. Judicial Review of Administrative Action.

International Law

1. Nature and Definition of International Law.

2. Relationship between International Law and Municipal Law

3. State Recognition and State Succession.

4. Sea: Inland Waters, Territorial Sea, Contiguous Zone, Continental Shelf, Exclusive Economic Zone and High Seas.

5. Individuals , nationality, statelessness; Human Rights and procedures available for their enforcement.

6. Territorial jurisdiction of States, Extradition and Asylum.

7. Treaties: Formation application, termination and reservation.

8. United Nations: Its principal organs, powers, and functions.

9. Settlement of Disputes.

10. Lawful recourse to force: aggressions, self-defence, intervention.

11. Legality of the use of nuclear weapons; ban on testing of nuclear weapons; Nuclear non proliferation treaty, CTBT.

12. International Terriorism State sponsored terrorism, Hijacking, International Criminal Court.

13. New International Economic order and Monetary law: WTO, TRIPS, GATT, IMF, World Bank.

14. Protection and Improvement of the Human Environment: International Efforts.

Law of Crimes:-

1. General Principles of Criminal Liability: mens rea and actus reus, Mens rea in statutory offences.

2. Application of the Indian Penal Code.

3. Kinds of Punishment.

4. Preparations and criminal attempts

5. General exceptions.

6. Joint and constructive liability.

7. Abetment.

8. Criminal conspiracy.

9. Offences against the State.

10. Offences against public tranquility.

11. Offences against human body.

12. Offences against property

13. Offences Relating to Marriage.

14. Defamation

15. Protection of Civil Rights Act, 1955

16. Dowry Prohibition Act, 1961

17. Prevention of Corruption Act, 1988.

Law of Torts :

1. Nature and definition.

2. Liability based upon fault and strict liability

3. Vicarious liability including State Liability.

4. General defences.

5. Joint tortfeasors.

6. Remedies.

7. Negligence

8. Defamation.

9. Nuisance.

10. Conspiracy

11. False imprisonment.

12. Malicious Prosecution.

13. Consumer Protection Act, 1986.

Law of Contracts and Mercantile Law

1. Formation of Contract

2. Factors vitiating consent

3. Void voidable, illegal and unenforceable agreements.

4. Performance and discharge of contracts.

5. Quasi-contracts.

6. Consequences of breach of contract

7. Contract of Agency.

8. Sale of goods and hire purchase.

9. Formation and dissolution of partnership

10. Negotiable Instruments Act, 1881.

11. Arbitration and Conciliation Act, 1996.

English – Optional

Answers must be written in English.

Texts for detailed study are listed below. Candidates will also be required to show adequate knowledge of the following topics and movements :

The Renaissance : Elizabethan and Jacobean Drama; Metaphysical Poetry; The Epic and the Mock-epic; Neo-classicism; Satire; The Romantic Movement; The Rise of the Novel; The Victorian Age.

1. William Shakespeare : **King Lear** and **The Tempest.**

2. John Donne. The following poems :

- Canonization;

- Death be not proud;

- The Good Morrow;

- On his Mistress going to bed;

- The Relic;

3. John Milton : **Paradise Lost,** I, II, IV, IX

4. Alexander Pope. **The Rape of the Lock.**

5. William Wordsworth. The following poems:

- Ode on Intimations of Immortality.
- Tintern Abbey.
- Three years she grew.
- She dwelt among untrodden ways.
- Michael.
- Resolution and Independence.
- The World is too much with us.
- Milton, thou shouldst be living at this hour.
- Upon Westminster Bridge.

6. Alfred Tennyson : **In Memoriam.**

7. Henrik Ibsen : **A Doll's House.**

8. Jonathan Swift. **Gulliver's Travels**.

9. Jane Austen. **Pride and Prejudice.**

10. Henry Fielding. **Tom Jones.**

11. Charles Dickens. **Hard Times.**

12. George Eliot. **The Mill on the Floss**.

13. Thomas Hardy. **Tess of the d'Urbervilles**.

14. Mark Twain. **The Adventures of Huckleberry Finn**.

Texts for detailed study are listed below. Candidates will also be required to show adequate knowledge of the following topics and movements :

Modernism; Poets of the Thirties; The stream-of-consciousness Novel; Absurd Drama; Colonialism and Post-Colonialism; Indian Writing in English; Marxist, Psychoanalytical and Feminist approaches to literature; Post-Modernism.

1. William Butler Yeats. The following poems:

- Easter 1916
- The Second Coming
- A Prayer for my daughter.
- Sailing to Byzantium.
- The Tower.
- Among School Children.
- Leda and the Swan.
- Meru
- Lapis Lazuli
- The Second Coming
- Byzantium.

2. T.S. Eliot. The following poems :

- The Love Song of J.Alfred Prufrock
- Journey of the Magi.
- Burnt Norton.

3. W.H. Auden. The following poems :

- Partition
- Musee des Beaux Arts
- in Memory of W.B. Yeats
- Lay your sleeping head, my love
- The Unknown Citizen
- Consider

- Mundus Et Infans

- The Shield of Achilles

- September 1, 1939

- Petition.

4. John Osborne : **Look Back in Anger.**

5. Samuel Beckett. **Waiting for Godot.**

6. Philip Larkin. The following poems :

- Next

- Please

- Deceptions

- Afternoons

- Days

- Mr. Bleaney

7. A.K. Ramanujan. The following poems :

- Looking for a Causim on a Swing

- A River

- Of Mothers, among other Things

- Love Poem for a Wife 1

- Samll-Scale Reflections on a Great House

- Obituary

(All these poems are available in the anthology Ten Twentieth Century Indian Poets, edited by R. Parthasarthy, published by Oxford University Press, New Delhi).

1. Joseph Conrad. **Lord Jim**

2. James Joyce. **Portrait of the Artist as a Young Man.**

3. D.H. Lawrence. **Sons and Lovers.**

4. E.M. Forster. **A Passage to India.**

5. Virginia Woolf. **Mrs Dalloway.**

6. Raja Rao. **Kanthapura**.

7. V.S. Naipal. **A House for Mr. Biswas.**

Hindi – Optional

Answers must be written in Hindi.

1.History of Hindi Language and Nagari Lipi.

I. Grammatical and applied forms of Apbhransh, Awahatta & Arambhik Hindi.

II. Development of Braj and Awadhi as literary language during medieval period.

III. Early form of Khari-boli in Siddha-Nath Sahitya, Khusero, Sant Sahitaya, Rahim etc. and Dakhni Hindi.

IV. Development of Khari-boli and Nagari Lipi during 19th Century.

V. Standardisation of Hindi Bhasha & Nagari Lipi.

VI. Development of Hindi as national Language during freedom movement.

VII. The development of Hindi as a National Language of Union of India.

VIII. Scientific & Technical development of Hindi Language.

IX. Prominent dialects of Hindi and their inter relationship.

X. Salient features of Nagari Lipi and the efforts for its reform & Standard form of Hindi.

XI. Grammatical structure of Standard Hindi.

2. History of Hindi Literature.

I. The relevance and importance of Hindi literature and tradition of writing History of Hindi Literature.

II. Literary trends of the following four periods of history of Hindi Literature.

A : Adikal-Sidh, Nath and Raso Sahitya.

Prominent poets-Chandvardai, Khusaro, Hemchandra, Vidyapati.

B : Bhaktikal-Sant Kavyadhara, Sufi Kavyadhara, Krishna Bhaktidhara and Ram Bhaktidhara.

Prominent Poets-Kabir, Jayasi, Sur & Tulsi.

C: Ritikal-Ritikavya, Ritibaddhakavya & Riti Mukta Kavya.

Prominent Poets-Keshav, Bihari, Padmakar and Ghananand.

D : Adhunik Kal

a. Renaissance, the development of Prose, Bharatendu Mandal.

b. Prominent Writers : Bharatendu, Bal Krishna Bhatt & Pratap Narain Mishra.

c. Prominent trends of modern Hindi Poetry : Chhayavad, Pragativad, Proyogvad, Nai Kavita, Navgeet and Contemporary poetry and Janvadi Kavita.

Prominent Poets : Maithili Sharan Gupta, Prasad, Nirala, Mahadevi, Dinkar, Agyeya, Muktibodh, Nagarjun.

3. Katha Sahitya

A. Upanyas & Realism

B. The origin and development of Hindi Novels.

C. Prominent Novelists : Premchand, Jainendra, Yashpal, Renu and Bhism Sahani.

D. The origin and development of Hindi short story.

E. Prominent short Story Writers : Premchand, Prasad, Agyeya, Mohan Rakesh & Krishna Shobti.

4. **Drama & Theatre**

A. The origin & Development of Hindi Drama.

B. Prominent Dramatists : Bharatendu, Prasad, Jagdish Chandra Mathur, Ram Kumar Verma, Mohan Rakesh.

C. The development of Hindi Theature.

5. **Criticism**

A : The origin and development of Hindi criticism : Saiddhantik, Vyavharik, Pragativadi, Manovishleshanvadi & Nai Alochana.

B : Prominent critics : Ramchandra Shukla, Hajari Prasad Dwivedi, Ram Vilas Sharma & Nagendra.

6. The other forms of Hindi prose-Lalit Nibandh, Rekhachitra, Sansmaran, Yatra-vrittant.

This portion will require first hand reading of prescribed texts and will test the critical ability of the candidates.

7. Kabir : Kabir Granthawali, Ed, Shyam Sundar Das (First hundred Sakhis.)

8. Surdas : Bhramar Gitsar, Ed. Ramchandra Shukla (First hundred Padas)

9. Tulsidas : Ramchrit Manas (Sundar Kand) Kavitawali (Uttar Kand).

10. Jayasi : Padmawat Ed. Shyam Sundar Das (Sinhal Dwip Khand & Nagmativiyog Khand)

11. Bihari : Bihari Ratnakar Ed. Jagnnath Prasad Ratnakar (First 100 Dohas)

12. Maithili Sharan Gupta : Bharat Bharati

13. Prasad : Kamayani (Chinta and Sharddha Sarg)

14. Nirala : Rag-Virag, Ed. Ram Vilas Sharma (Ram Ki Shakti Puja & Kukurmutta).

15. Dinkar : Kurushetra

16. Agyeya : Angan Ke Par Dwar (Asadhya Vina)

17. Muktiboth : Brahma Rakshas

18. Nagarjun : Badal Ko Ghirte Dekha Hai, Akal Ke Bad, Harijan Gatha.

19. Bharatendu : Bharat Durdasha

20. Mohan Rakesh : Ashad Ka Ek Din

21. Ramchandra Shukla : Chintamani (Part I)

(Kavita Kya Hai] Shraddha Aur Bhakti)

22. Dr. Satyendra : Nibandh Nilaya-Bal Krishna Bhatt, Premchand, Gulab Rai, Hajari Prasad Dwivedi, Ram Vilas Sharma, Agyeya, Kuber Nath Rai.

23. Premchand : Godan, Premchand ki Sarvashreshtha Kahaniyan, Ed. Amrit Rai, Manjusha - Premchand ki Sarvashreshtha Kahaniyan, Ed. Amrit Rai

24. Prasad : Skandgupta

25. Yashpal : Divya

26. Phaniswar Nath Renu : Maila Anchal

27. Mannu Bhandari : Mahabhoj

28. Rajendra Yadav : Ek Dunia Samanantar (All Stories)

MANIPURI – Optional

Answers must be written in Manipuri.

Language :

A) General characteristics of Manipuri Language and history of its development; its importance and status among the Tibeto-Burman Languages of North-East India; recent development in the study of Manipuri language; evolution and study of old Manipuri script.

B) Significant features of Manipuri language :

i) Phonology-Phoneme-vowels, consonants juncture, tone, consonant cluster and its occurrence, syllable-its structure, pattern and types.

ii) Morphology : Word-class, root and its types; affix and its types; grammatical categories-gender, number, person, case, tense and aspects, process of compounding (samas and sandhi).

iii) Syntax : Word order : types of sentences, pharse and clause structures.

C) Literary History of Manipuri :

Early period (upto 17th century)-Social and cultural background; Themes, diction and style of the works.

Medieval period (18th and 19th century)- Social, religious and political background; Themes, diction and style of the works.

Modern period-Growth of major literary forms; change of Themes, diction and style.

D) Manipuri Folk Literature :

Legend, Folktale, Folksong, Ballad, Proverb and Riddle.

E) Aspects of Manipuri Culture :

Pre-Hindu Manipuri Faith; Advent of Hinduism and the process of syncreticism.

Performing arts-Lai Haraoba, Maha Ras; Indegenous games-Sagol Kangjei, Khong Kangjei, Kang.

This portion will require first hand reading of the texts prescribed and will be designed to test the candidate's critical ability to assess them.

Old and Medieval Manipuri Literature

A) **Old Manipuri Literature**

1. O. Bhogeswar Singh (Ed.) : Numit Kappa

2. M. Gourachandra Singh (Ed.) : Thawanthaba Hiran

3. N. Khelchandra Singh (Ed.) : Naothingkhong Phambal Kaba

4. M. Chandra Singh (Ed.) : Panthoibi Khonggul

B) **Medieval Manipuri Literature :**

1. M. Chandra Singh (Ed.) : Samsok Ngamba

2. R.K.Snahal Singh (Ed.) : Ramayana Adi Kanda

3. N. Khelchandra SIngh (Ed.) : Dhananjoy Laibu Ningba

4. O. Bhogeswar Singh (Ed.) : Chandrakirti Jila Chatpa

Modern Manipuri Literature :

A) **Poetry and Epic :**

(I) **Poetry :**

a) Manipuri Sheireng (Pub) Manipuri Sahitya Parishad, 1988 (ed.)

Kh. Chaoba Singh : Pi Thadoi, Lamgi Chekla Amada, Loktak Mapanda

Dr. L. Kamal Singh : Nirjanata, Nirab Rajani

A. Minaketan Singh : Kamalda, Nonggumlakkhoda

L. Samarendra Singh : Ingagi Nong, Mamang Leikai Thambal Satle

E. Nilakanta Singh : Manipur, Lamangnaba

Shri Biren : Tangkhul Hui

Th. Ibopishak : Anouba Thunglaba Jiba

b) Kanchi Sheireng. (Pub) Manipur University 1998 (ed.)

Dr. L. Kamal Singh : Biswa-Prem

Shri Biren : Chaphadraba Laigi Yen

Th. Ibopishak : Norok Patal Prithivi

(II) **Epic :**

1. A. Dorendrajit Singh : Kangsa Bodha

2. H. Anganghal Singh : Khamba-Thoibi Sheireng (San-Senba, Lei-Langba, Shamu Khonggi Bichar)

(III) **Drama :**

1. S. Lalit Singh : Areppa Marup

2. G.C. Tongbra : Matric Pass

3. A. Samarendra : Judge Sahebki Imung

b) **Novel, Short-story and Prose :**

(I) **Novel :**

1. Dr. L. Kamal Singh : Madhabi

2. H. Anganghal Singh : Jahera

3. H. Guno Singh : Laman

4. Pacha Meetei : Imphal Amasung, Magi Ishing, Nungsitki Phibam

(II) **Short-story :**

a) Kanchi Warimacha (Pub) Manipur University 1997 (ed.)

R.K. Shitaljit Singh : Kamala Kamala

M.K. Binodini : Eigi Thahoudraba Heitup Lalu

Kh. Prakash : Wanom Shareng

b) Parishadki Khangatlaba Warimacha (Pub) Manipuri Sahitya Parishad 1994 (ed.)

S. Nilbir Shastri : Loukhatpa

R.K. Elangba : Karinunggi

c) Anouba Manipuri Warimacha (Pub) The Cultural Forum Manipur 1992 (ed.)

N. Kunjamohon Singh : Ijat Tanba

E. Dinamani : Nongthak Khongnang

(III) **Prose :**

a) Warenggi Saklon [Due Part (Pub) The Cultural Forum Manipur 1992 (ed.)

Kh. Chaoba Singh : Khamba-Thoibigi Wari Amasung Mahakavya

b) Kanchi Wareng (Pub) Manipur University 1998 (ed.)

B. Manisana Shastri : Phajaba

Ch. Manihar Singh : Lai-Haraoba

c) Apunba Wareng. (Pub) Manipur University, 1986 (ed.)

Ch. Pishak Singh : Samaj Amasung, Sanskriti

M.K. Binodini : Thoibidu Warouhouida

Eric Newton : Kalagi Mahousa (translated by I.R. Babu)

d) Manipuri Wareng (Pub) The Cultural Forum Manipur 1999 (ed.)

S. Krishnamohan Singh : Lan

Management – Optional

The candidate should make a study of the concept and development of management as science and art drawing upon the contributions of leading thinkers of management and apply the concepts to the real life of government and business decision making keeping in view the changes in the strategic and operative environment.

I. **Managerial Function :** Concept and foundations of Management, Managerial role and functions. Analysis of Environmental opportunities and threats, Formulation of Organisational Vision, Mission and Objectives. Decision Making.

II. **Organisational Behaviour and Design :** Classical and Neoclassical Systems, Delegation of Authority, Design of Strategic Business Units. Theories of motivation and their relevance. Communication. Leadership. Understanding group behaviour and dynamics. Conflict Management. Managing Change. Innovation in Organizational Design such as Networks, Knowledge Based Enterprises-Systems and Processes.

III. **Quantitative Techniques in Decision Making :** Classification of data, Averages, Dispersion and Skewness. Correlation and Regression. Time- Series Analysis & Forecasting Techniques. Elementary concepts of Binomial, Poisson and Normal Distributions. Tests of Significance 't', 'F' and Chisquare. Linerar Programming-Problem formulation-Simplex method and Graphical solution. PERT and CPM. Decision making under uncertainity.

IV. **Management Control System :** Basic concepts, Understanding strategic behaviour. Responsibility Centres, Strategic Planning, Preparation of budgets, Zero Based Budget, Analysis and Evaluation of Performance, Control System in Service Organization. Modern Control Methods, Controlling Global Enterprises: Transfer Pricing and Management of Risk.

V. **Strategic Cost Management :** Value Chain : Conceptual issues and Applications. Cost analysis-Activity based costing, Cost Drivers and their measurement. Target Costing. Profit Variance Analysis.

VI. **Business Environment :** Concept and Analysis of Macro-business environment: Indian and global. Analysis of structural dimensions of Indian Economy. Directions of change and impact on business decision. Regulatory and promotional Policies. Liberalization, Globalisation and Corporatisation Problems and Prospects.

I. **Financial Management :** Goal of Finance Function. Analysis of Financial Postion: Ratio and Funds Flow Analysis. Concepts of value and return. Valuation of Bonds and Shares. Risk and Return: Portfolio Theory, CAPM and APM. Option Pricing. Financial and Operating leaverage. Design of Capital Structure; Theories and Practices. Management of Working Capital: Estimation and Financing.

Management of Cash, Receivables and Inventory and Current Liabilities. Capital and Money Markets: Institutions and Instruments. Leasing, Hirepurchase and veartur capital mergers and acquistions. Shareholder Value Creation: Dividend Policy, Corporate financial policy and strategy., Management of corporate distress and restructuring strategy. Regulation of capital market.

II. **Marketing Management :** Concept and strategy. Analysis of marketing environment and planning process. Understanding and selecting target markets: Marketing Research, Consumer Behaviour. Segmentation, Targeting and Postitioning., Product management. Distribution channels and logistics. Public Distribution System. Marketing Communciation, Brand Management. personal selling and management of salesforce. Pricing decisions. Understanding competitive strategy. Design, implementation and control. Services and non-profit marketing. Social Marketing. Creating global competitive Advantage: Analysis, formulation, implementation and control. Evaluation of marketing function. Ethics in marketing: Consumer protection. E-Business.

III. **International Business :** International Business Environment: Changing composition of trade in goods and services. Emerging areas of trade. Evaluation of International Trade Policies-instruments of trade policy, institutions of international business GATT//WTO, Trims and Trips-Labour conditions and environmental issues. trade in services and agri products. role of IMF, World Bank, UNCTAD. Regional Economic Cooperation. Export Marketing Management-Overseas market research, Export pricing and finance. Management of risk. Export-import procedures. Tole of intermediaries and documentation.

IV. **Operation and Materials Management :** Fundamentals of Operations Management. Organising for Production. Aggregate Production Planning, Capacity Planning, Plan Design: Process planning plant size and scale of operations. Management of facilities. Equipment replacement and maintenance. Production cotnrol. Supply Chain Management-Vendor Evaluation and Audit. Quality Management.

Role and importance of Materials Management , Material Handling, Value Analysis, Quality control, Make or Buy Decision. Codification, Standardisation of spare parts inventory. Inventory Control. Two Bin System. Waste Management, Purchasing process and procedure. International Buying.

V. **Management Information System :** Conceptual foundations of Information System. Information Resource Management. System Development-Overview of Systems and Design. System Development Management life-cycle, Designing on-line and Distributed environments. Implementation and Control of Project. Trends in Information Technology. Managing Data Resources-Organising Data. DSS and RDBMS.

VI. **Human Resource Development :** Concept and Policies. Man-power planning; recruitment, Selection, trainging, development, promotion and transfer. Performance Management-job evaluation, job enrichment. Compensation Management. Employee Morale and Productivity. Management of Organisational Climate and Industrial Relations. Humans Resource Accouting and Audit.

Mathematics – Optional

Linear Algebra

Vector, space, linear dependance and independance, subspaces, bases, dimensions. Finite dimensional vector spaces.

Matrices, Cayley-Hamiliton theorem, eigenvalues and eigenvectors, matrix of linear transformation, row and column reduction, Echelon form, eqivalence, congruences and similarity, reduction to cannonical form, rank, orthogonal, symmetrical, skew symmetrical, unitary, hermitian, skew-hermitian forms–their eigenvalues. Orthogonal and unitary reduction of quadratic and hermitian forms, positive definite quardratic forms.

Calculus

Real numbers, limits, continuity, differerentiability, mean-value theorems, Taylor's theorem with remainders, indeterminate forms, maximas and minima, asymptotes. Functions of several variables: continuity, differentiability, partial derivatives, maxima and minima, Lagrange's method of multipliers, Jacobian. Riemann's definition of definite integrals, indefinite integrals, infinite and improper intergrals, beta and gamma functions. Double and triple integrals (evaluation techniques only). Areas, surface and volumes, centre of gravity.

Analytic Geometry :

Cartesian and polar coordinates in two and three dimesnions, second degree equations in two and three dimensions, reduction to cannonical forms, straight lines, shortest distance between two skew lines, plane, sphere, cone, cylinder., paraboloid, ellipsoid, hyperboloid of one and two sheets and their properties.

Ordinary Differential Equations :

Formulation of differential equations, order and degree, equations of first order and first degree, integrating factor, equations of first order but not of first degree, Clariaut's equation, singular solution.

Higher order linear equations, with constant coefficients, complementary function and particular integral, general solution, Euler-Cauchy equation.

Second order linear equations with variable coefficients, determination of complete solution when one solution is known, method of variation of parameters.

Dynamics, Statics and Hydrostatics :

Degree of freedom and constraints, rectilinerar motion, simple harmonic motion, motion in a plane, projectiles, constrained motion, work and energy, conservation of energy, motion under impulsive forces, Kepler's laws, orbits under central forces, motion of varying mass, motion under resistance.

Equilibrium of a system of particles, work and potential energy, friction, common catenary, principle of virtual work, stability of equilibrium, equilibrium of forces in three dimensions.

Pressure of heavy fluids, equilibrium of fluids under given system of forces Bernoulli's equation, centre of pressure, thrust on curved surfaces, equilibrium of floating bodies, stability of equilibrium, metacentre, pressure of gases.

Vector Analysis :

Scalar and vector fields, triple, products, differentiation of vector function of a scalar variable, Gradient, divergence and curl in cartesian, cylindrical and spherical coordinates and their physical interpretations. Higher order derivatives, vector identities and vector quations.

Application to Geometry: Curves in space, curvature and torision. Serret-Frenet's formulae, Gauss and Stokes' theorems, Green's identities.

Algebra:

Groups, subgroups, normal subgroups, homomorphism of groups quotient groups basic isomorophism theorems, Sylow's group, permutation groups, Cayley theorem. Rings and ideals, principal ideal domains, unique factorization domains and Euclidean domains. Field extensions, finite fields.

Real Analysis :

Real number system, ordered sets, bounds, ordered field, real number system as an ordered field with least upper bound property, cauchy sequence, completeness, Continuity and uniform continuity of functions, properties of continuous functions on compact sets. Riemann integral, improper integrals, absolute and conditional convergence of series of real and complex terms, rearrangement of series. Uniform convergence, continuity, differentiability and integrability for sequences and series of functions. Differentiation of fuctions of several variables, change in the order of partial derivatives, implict function theorem, maxima and minima. Multiple integrals.

Complex Analysis : Analytic function, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's integral formula, power series, Taylor's series, Laurent's Series, Singularities, Cauchy's residue theorem, contour integration. Conformal mapping, bilinear transformations.

Linear Programming :

Linear programming problems, basic solution, basic feasible solution and optimal solution, graphical method and Simplex method of solutions. Duality.

Transportation and assignment problems. Travelling salesman problems.

Partial differential equations:

Curves and surfaces in three dimesnions, formulation of partial differential equations, solutions of equations of type dx/p=dy/q=dz/r; orthogonal trajectories, pfaffian differential equations; partial differential equations of the first order, solution by Cauchy's method of characteristics; Charpit's method of solutions, linear partial differential equations of the second order with constant coefficients, equations of vibrating string, heat equation, laplace equation.

Numerical Analysis and Computer programming:

Numerical methods: Solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods, solution of system of linear equations by Gaussian elimination and Gauss-Jordan (direct) methods, Gauss-Seidel(iterative) method. Newton's (Forward and backward) and Lagrange's method of interpolation.

Numerical integration: Simpson's one-third rule, tranpezodial rule, Gaussian quardrature formula.

Numerical solution of ordinary differential equations: Euler and Runge Kutta-methods.

Computer Programming: Storage of numbers in Computers, bits, bytes and words, binary system. arithmetic and logical operations on numbers. Bitwise operations. AND, OR , XOR, NOT, and shift/rotate operators. Octal and Hexadecimal Systems. Conversion to and form decimal Systems.

Representation of unsigned integers, signed integers and reals, double precision reals and long integers.

Algorithms and flow charts for solving numerical analysis problems.

Developing simple programs in Basic for problems involving techniques covered in the numerical analysis.

Mechanics and Fluid Dynamics :

Generalised coordinates, constraints, holonomic and non-holonomic , systems. D' Alembert's principle and Lagrange' equations, Hamilton equations, moment of intertia, motion of rigid bodies in two dimensions.

Equation of continuity, Euler's equation of motion for inviscid flow, stream-lines, path of a particle, potential flow, two-dimensional and axisymetric motion, sources and sinks, vortex motion, flow past a cylinder and a sphere, method of images. Navier-Stokes equation for a viscous fluid.

Mechanical Engineering – Optional

1. **Theory of Machines**

Kinematic and dynamic analysis of planar mechanisms. Cams, Gears and gear trains, Flywheels, Governors, Balancing of rigid rotors, Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems (single degree and two degrees of freedom), Critical speeds and whirling of shafts, Automatic Controls, Belts and chain drives. Hydrodynamic bearings.

2. **Mechanics of Solids :**

Stress and strain in two dimensions. Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and an isotropy, Stress-strain relations, unilaxial loading, thermal stresses. Beams : Banding moment and shear force diagrams, bending stresses and deflection of beams, Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, Thick and thin walled pressure vessels. Struls and columns, Strain energy concepts and theories of failure. Rotating discs. Shrink fits.

3. **Engineering Materials :**

Basic concepts on structure of solids, Crystalline materials, Defects in crystalline materials, Alloys and binary phase diagrams, structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite Materials, common applications of various materials.

4. **Manufacturing Science :**

Marchant's force analysis, Taylor's tool life equation, machinability and machining economics, Rigid, small and flexible automation, NC, CNC. Recent machining methods- EDM, ECM and ultrasonics. Application of lasers and plasmas, analysis of forming processes. High energy rate forming. Jigs, fixtures, tools and gauges, Inspection of length, position, profile and surface finish.

5. **Manufacturing management :**

Production Planning and Control, Forecasting-Moving average, exponential smoothing, Operations sheduling; assembly line balancing. Product development. Breakeven analysis, Capacity planning. PERT and CPM.

Control Operations : Inventory control-ABC analysis. EOQ model. Materials requirement planning. Job design, Job standards, work measurement, Quality management-Quality control. Operations Research : Linear programming-Graphical and Simplex methods. Transportation and assignment models. Single server queuing model.

Value Engineering : Value analysis, for cost/value. Total quality management and forecasting techniques. Project management.

6. **ELEMENTS OF COMPUTATION :**

Computer Organisation, Flow charting. Features of Common Computer Languages-FORTRAN d Base III, Lotus 1-2-3 C and elementary programming.

1. **THERMODYNAMICS :**

Basic concept. Open and closed systems, Applications of Thermodynamic Laws, Gas equations, Clapeyron equation, Availability, Irreversibility and Tds relations.

2. **I.C. Engines, Fuels and Combustion :**

Spark ignition and compression ignition engines, Four stroke engine and Two stroke engines, mechanical, thermal and volumetric efficiency, Heat balance.

Combustion process in S.I. and C.I. engines, preignition detonation in S.I. engine Diesel knock in C.I. engine. Choice of engine fuels, Octance and Cetane retings. Alternate fuels Carburration and Fuel injection, Engine emissions and control. Solid, liquid and gaseous fuels, stoichometric air requirements and excess air factor, fuel gas analysis, higher and lower calorific values and their measurements.

3. **HEAT TRANSFER, REFRIGERATION AND AIR CONDITIONING :**

One and two dimensional heat conduction. Heat transfer from extended surfaces, heat transfer by forced and free convection. Heat exchangers. Fundamentals for diffusive and connective mass transfer, Radiation laws, heat exchange between black and non black surfaces, Network Analysis. Heat pump refrigeration cycles and systems, Condensers, evaporators and expansion devices and controls. Properties and choice of refrigerant, Refrigeration Systems and components, psychometrics, comfort indices, cooling loading calculations, solar refrigeration.

4. **TURBO-MACHINES AND POWER PLANTS :**

Continuity, momentum and Energy Equations. Adiabatic and Isentropic flow, fanno lines, Raylegh lines. Theory and design of axial flow turbines and compressors, Flow through turbo-machine balde, cascades, centrifugal compressor. Dimensional analysis and modelling. Selection of site for steam, hydro, nuclear and stand-by power plants, Selection base and peak load power plants, Modern High pressure, High duty boilers, Draft and dust removal equipment, Fuel and cooling water systems, heat balance, station and plant heat rates, operation and maintenance of various power plants, preventive maintenance, economics of power generation.

MEDICAL SCIENCE – Optional

I. **Human Anatomy :** Gross and microscopic anatomy and movements of shoulder, hip and knee joints; Blood supply, nerve innervation of hand, Lymphatic system; Karyotyping, medical genetics; Electron microscopic structure of glomerulous and muscle; Gross and microscopic anatomy and blood supply of lungs, heart, kidneys, liver, testis and uterus; Gross anatomy of pelvis, perineum and inguinal region. Cross-sectional anatomy of the body and mid-thoracic, upper abdominal, mid-abdominal and pelvic regions.

Embryology : Major steps in the development of lung, heart, kidney, urinary bladder, uterus, ovary, testis and their common congenital abnormalities; Placenta and placental barrier.

Anatomy of central and peripheral autonomic nervous system :

Neural pathways for cutaneous sensations and vision; Cranial nerves, distribution and clinical significance; Anatomy of autonomic control of gastronintestinal, respiratory and reproductive systems.

II. **Human Physiology :** Central, peripheral and autonomic nervous. system; Nerve and muscle excitation, conduction and transmission of impulse, mechanism of contraction, neurovascular transmission, EMG; Synaptic transmission, reflexes, control of equilibrium, posture and muscle tone descendig pathways, functions of creebellum, basal ganglia, reticular formation, hypothalamus limbic system and cerebral cortex; Physiology of sleep and consciousness, EEG.; Higher functions of the brain; Vision and hearing.

Endocrine system : Mechanism of action of hormones, formation, secretion, transport, metabolism, functions and regulations of secretion of pancreas and pituitary glands.

Physiology of reproductive system : menstrual cycle, lactation, pregnancy.

Blood : Development, regulations and fate of blood cells.

Cardio-vascular, respiratory gastro-intestinal and renal physiology : Cardiac excitation, spread of cardiac impulse, ECG., cardiac output, blood pressure, regulation of cardiovascular functions; Mechanics of respiration and regulation of respiration; Digestion and absorption of food, regulation of secretion and motility of gastrointesinal tract; Glomerular and tubular fucntions of kidney.

III. **Biochemistry :** pH and pK Hendrson-Hassebalch Equation; Properties and regulation of enzyme activity, role of high energy phosphates in bioenergetics; Sources, daily requirements, action and toxicity of vitamins; Metabolism of lipids, carbohydrates, proteins, disorders of their metabolism; Chemical nature, structure, synthesis and fucntions of nucleic acids and proteins; Distribution and regulation of body water and minerals including trace elements; Blood Gas Analysis, GTT, Immuno electrophorises, molecular structure of muscle contractile protein, oestrogen receptors.

I. **Pathology :** Rection of cell and tissue of injury, inflammation and repair , disturbances of growth and cancer. genetic diseases; Pathogenesis and histopathology of Rheumatic and ischaemic heart disease; Bronchogenic carcinoma, carcinoma breast, oral cancer, cancer colon. Lymphoma, leukaemia, liver cancer, meningioma and meningitis; Etiology, pathognesis and histopathology of - Peptic ulcer, cirrhosis liver glomerulonephritis, lobar pneumonia, acute osteomyelitis, hepatitis, acute pancreatitis.

II. **Microbiology :** Growrth of micro-organisms, sterilization and disinfection, bacterial genetics, virus-cell interactions; Immunological principles, acquired immunity, immunity in infections cause by viruses; Diseases caused by and laboratory diagnosis of Staphylococcus, enterococcus, salmonella, shigella, secheichiza, pseudomonos, vibrio, adenoviruses, herpes viruses (including rubella_, fungi, protozoa, helminths, leptospiral infection.

III. **Pharmacology :** Drug receptor instruction, mechanism of drug action; Mechanism of action, dosage, metabolism and side effects of - Pilocarpine, terbutaline, metoprolol diazepam, acetylsalicylic acid, ibuprofen, furosemide, metronidazole. Chloroquin. Mechanism of action, dosage and toxicity of- Ampicillin, Cephalosporins, 1,2,3,4,th generations, Aminoglycoside, Doxycycline, chloramphenicol, rifampin, Calcium channel blocker, beta blocker, ace inhibitors, immunosuppressive therapy. Indications, dosage, side-effects and contraindictions of- Methortrexate, vincristin, tamoxifen. Classification, route of administration, mechanism of action and side effects of - General anaesthetics, hypnotics, analgesics, Anti-viral, anti-fungal drugs.

IV. **Forensic Medicine and Toxicology :** Forensic examination of injuris and wounds; Physical and chemical examination of blood and seminal stains; Organo phosphorous poisoning, sedative overdose, hanging, drowning, burns, snake envenomation.

1. **General Medicine :**

Etiology, clinical features, diagnosis and principles of management (including prevention) of:-

Malaria, Typhoid, Cholera, Tetanus, Rabies, Exanthematous Fevers, Tuberculosis, AIDS.

Etiology, clinical features, diagnosis and principles of management of:

Rheumatic, ischaemic and congenital heart disease, hypertension. Cardiomyopathy, pulmonary embolism.

Acute and chronic respiratory infections, bronchial asthma.

Occupational lung disease, pleural effusion, disseminated tuberculosis Malabsorption syndromes, acid peptic diseases, haemetemesis. Viral hepatitis, cirrhosis of liver, alcoholic liver disease.

Actue glomerulonerphritis, chronic pyelonephritis, renal failure, nephrotic syndrome, renovascular hypertension, diabeties mellitus, anaemias, coagulation disorders, leukaemia, polycythemia and hyperviscosity syndrome, meningitis encephalitis, carebrovascular diseases.

Role of Immageology in the work-up of medical problems, ultrasound, echo cardiogram, CT scan MRI.

Psychiatry : Common psychiatric disorders, schizophrenia. ECT, lithium

II. **Paediatrics :** Common paediatric problems, congenertal cyanotic heart disease, respiratory distress syndrome, broncho pneumonias, kernicterus. Aids- prevention of vertical transmission.

III. **Dermatology :** Common skin diseases, psoariasis, Hansen's disease, fungal dermatitis, scabies, eczema, vitiligo, Stevan Johnsons's syndrome.

I. **General Surgery :**

Clinical features, causes diagnosis and principles of management of:

Cervical lymph node enlargement, parotid tumour, oral cancer, cleft palate, hare lip.

Laryngeal tumour, esophageal tumours.

Peripheral arterial diseases, varicose veins, coarctation of arota

Dysfunctions of thyroid parathyroids and adrenals.

Tumours of Thyroid, Parathyroid, Adrenal, Pituitary Glands.

Abscess of breast, cancer breast, fibroadenoma and adenosis

Acute and chronic appendicitis, bleeding peptic ulcer, tuberculosis of bowel, intestinal obstruction, ulcerative colitis.

Renal mass, acute retention of urine, benign prostatic hypertrophy.

Haemonthorax, constrictive pericarditis

Splenomegaly, chronic cholexystitis, portal hypertension, liver abscess, peritonitis, carcinoma head of pancreas.

Direct and indirect inguinal hernias and their compliations.

Freactures of femur and spine, Colles' fracture and bone tumours.Organs transplantation, kidney, liver, heart, bone-marrow.Laprascopic Surgery.

II. **Obstetrics and gynaecology including Family Planning.**

Diagnosis of pregnancy, screening of high risk pregnancy, foetoplacental development.

Labour management, complications of 3rd stage, postpartum haemorrhage, resuscitation of the newborn.

Diagnosis and management of anaemia and pregnancy induced hypertension.

Principles of the following contraceptive methods.

Intra-uterine devices, pills, tubectomy and vasectomy. Medical termination of pregnancy including legal aspects.

Etiology, clinical features, diagnosis and principles of management of: Cancer cervic.

Leucorrhoea, pelvic pain, infertility, abnormal uterine bleeding, amenorrhoea.

III. **Preventive and Social medicine.**

Concept of causation and control of disease in the community, principles and methods of epidemiology.

Health hazards due to environmental pollution and industrialisation.

Normal nutrition and nutritional deficiency diseases in India.

Population trends (World and India),

Growth of population and its effect on health and development.

Objectives, components and critical analysis of each of the following National programmes for the control/eradication of:

Malaria, filaria, kala-azar, leprosy, tuberculosis, cancer, blindness, iodine deficiency disease, AIDS & std and guinea worm.

Objectives, components critical analysis of each of the following national Health and Family Welfare Programmes:

Maternal and child health, Family welfare, Nutrition,Immunization.

Philosophy – Optional

History and Problems of Philosophy

1. Plato : Theory of Ideas.

2. Aristotle : Form, Matter and causation.

3. Descartes : Cartesian Method and certain knowledge, God, Mind-Body Dualism.

4. Spinoza : Substance, Attributes and Modes, Pantheism; Bondage and Freedom.

5. Leibnitz : Monads; Theory of Perception God.

6. Locke : Theory of Knowledge, Rejection of Innate Ideas; substance and qualities.

7. Berkeley : Immaterialism, God, Criticism of representative Theory of Perception.

8. Hume : Theory of knowledge, Scepticism Self, Causality.

9. Kant : Distinctions between synthetic and analytic judgements and between aprion and aposteriori judgements, Space, Time Categories, Possibility of Synthetic Apriori Judgements, Ideas of Reason and Antinomics; Criticism of the Proofs for the Existence of God.

10. Hegel : Dialectical Method, Absolute Idealism.

11. Precursors of Linguistic Analysis : Moore (Defence of common sense, Reputaion of idealism), Russell (Theory of Descriptions).

12. Logical Atomism : Atomic Facts, Atomic sentences, Logical Constructions and Incomplete Symbols (Rusell), Distinction of saying and showing (Wittgenstein)

13. Logical Positivism : Verification theory and rejection of Metaphysics, Linguistic Theory of Necessary Propositions.

14. Phenomenology : Husserl.

15. Existentiaslism : Kierkegaard, Sartre.

16. Quine : Radical empiricism.

17. Strawson : theory of person.

18. Carvaka : Theory of Knowledge, Materialism.

19. Jainism : Theory of Reality, Saptabhangi Naya, Bondage and Liberation.

20. Buddhism : Pratityasamutpada, Ksanikavýds, Ñairãtmyavãda, Schools of Buddhism, Sautrantika Theory of Pramana, Ideal of Bodhisattva.

21. Samkhya : Prakriti, Purusa, Theory of Causation, Liberation.

22. Naya-Vãisesika : Theory of Pramãna, Self, Liberation, God and Proofs of God's Existence, Categories, Theory of Causation, Atomistic theory of Creation.

23. Mimãnsã : Theory of Knowledge.

24. Vedãnta : Schools of Vedãntã Sankara, Rãmãnuja, Madhva (Brahman, Isvara, Ãtman, Jiva, Jagat, Mãyã, Avidyã Adhyãsã, Moksã).

Socio-Political Philosophy

1. Political Ideals : Equality, Justice, Liberty.

2. Sovereignty (Austin, Boidin, Laski, Kautilya).

3. Individual and State.

4. Democracy; Concept and forms.

5. Socialism and Marxism.

6. Humanism.

7. Secularism.

8. Theories of punishment.

9. Co-existence and violence; Sarvoday.

10. Gender-Equality.

11. Scientific Temper and Progress.

12. Philosophy of Ecology.

Philosophy of Religion

1. Notions of God : Personalistic, Imparsonalistic, Naturalistic.

2. Prooofs of the Existence of God and their criticisms.

3. Immortality of Soul.

4. Liberation.

5. Problem of Evil.

6. Religious Knowledge : Reason, Revelation and Mysticism.

7. Religion without God.

8. Religion and Morality.

Physics – Optional

1. **Classical Mechanics**

(a) **Particle dynamics**

Centre of mass and laboratory coordinates, conservation of linear and angular momentum. The rocket equation. Rutherford scattering, Galilean transformation, intertial and non-inertial frames, rotating frames, centrifugal and Coriolis forces, Foucault pendulum.

(b) **System of particles**

Constraints, degrees of freedom, generalised coordinates and momenta. Lagrange's equation and applications to linear harmonic oscillator, simple pendulum and central force problems. Cyclic coordinates, Hamilitonian Lagrange's equation from Hamilton's principle.

(c) **Rigid body dynamics**

Eulerian angles, inertia tensor, principal moments of inertia. Euler's equation of motion of a rigid body, force-free motion of a rigid body. Gyroscope.

2. **Special Relativity, Waves & Geometrical Optics**

(a) **Special Relativity**

Michelson-Morley experiment and its implications. Lorentz transformations-length contraction, time dilation, addition of velocities, aberration and Doppler effect, mass-energy relation, simple applications to a decay process. Minkowski diagram, four dimensional momentum vector. Covariance of equations of physics.

(b) **Waves**

Simple harmonic motion, damped oscillation, forced oscillation and resonance. Beats. Stationary waves in a string. Pulses and wave packets. Phase and group velocities. Reflection and Refraction from Huygens' principle.

(c) **Geometrical Optics**

Laws of relfection and refraction from Fermat's principle. Matrix method in paraxial optic-thin lens formula, nodal planes, system of two thin lenses, chromatic and spherical aberrations.

3. **Physical Optics**

(a) **Interference**

Interference of light-Young's experiment, Newton's rings, interference by thin films, Michelson interferometer. Multiple beam interference and Fabry-Perot interferometer. Holography and simple applications.

(b) **Diffraction**

Fraunhofer diffraction-single slit, double slit, diffraction grating, resolving power. Fresnel diffraction: - half-period zones and zones plates. Fresnel integrals. Application of Cornu's spiral to the analysis of diffraction at a straight edge and by a long narrow slit. Diffraction by a circular aperture and the Airy pattern.

(c) **Polarisation and Modern Optics**

Production and detection of linearly and circularly polarised light. Double refraction, quarter wave plate. Optical activity. Principles of fibre optics attenuation; pulse dispersion in step index and parabolic index fibres; material dispersion, single mode fibres. Lasers-Einstein A and B coefficients. Ruby and He-Ne lasers. Characteristics of laser light-spatial and temporal coherence. Focussing of laser beams. Three-level scheme for laser operation.

4. **Electricity and Magnetism**

(a) **Electrostatics and Magnetostatics**

Laplace ad Poisson equations in electrostatics and their applications. Energy of a system of charges, multipole expansion of scalar potential. Method of images and its applications. Potential and field due to a dipole, force and torque on a dipole in an external field. Dielectrics, polarisation. Solutions to bounary-value problems-conducting and dielectric spheres in a uniform electric field. Magentic shell, uniformly magnetised sphere. Ferromagnetic materials, hysteresis, energy loss.

(b) **Current Electricity**

Kirchhoff's laws and their applications. Biot-Savart law, Ampere's law, Faraday's law, Lenz' law. Self-and mutual-inductances. Mean and rms values in AC circuits. LR CR and LCR circuits- series and parallel resonance. Quality factor. Principal of transformer.

5. **Electromagnetic Theory & Black Body Radiation**

(a) **Electromagnetic Theory**

Displacement current and Maxwell's equatons. Wave equations in vacuum, Poynting theorem. Vector and scalar potentials. Gauge invariance, Lorentz and Coulomb gauges. Electromagnetic field tensor, covariance of Maxwell's equations. Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two

dielectrics. Fresnel's relations. Normal and anomalous dispersion. Rayleigh scattering.

(b) **Blackbody radiation**

Balckbody radiation and Planck radiation law- Stefan-Boltzmann law, Wien displacement law and Rayleigh-Jeans law. Planck mass, Planck length, Planck time,. Planck temperature and Planck energy.

6. **Thermal and Statistical Physics**

(a) **Thermodynamics**

Laws of thermodynamics, reversible and irreversible processes, entropy. Isothermal, adiabatic, isobaric, isochoric processes and entropy change. Otto and Diesel engines, Gibbs' phase rule and chemical potential. van der Waals equation of state of a real gas, critical constants. Maxwell-Boltzman distribution of molecular velocities, transport phenomena, equipartition and virial theorems. Dulong-Petit, Einstein, and Debye's theories of specific heat of solids. Maxwell relations and applications. Clausius- Clapeyron equation. Adiabatic demagnetisation, Joule-Kelvin effect and liquefaction of gases.

(b) **Statistical Physics**

Saha ionization formula. Bose-Einstein condenssation. Thermodynamic behaviour of an ideal Fermi gas, Chandrasekhar limit, elementary ideas about neutron stars and pulsars. Brownian motion as a random walk, diffusion process. Concept of negative temperatures.

1. **Quantum Mechanics I**

Wave-particle dualitiy. Schroedinger equation and expectation values. Uncertainty principle. Solutions of the one-dimensional Schroedinger equation free particle (Gaussian wave-packet), particle in a box, particle in a finite well, linear harmonic oscillator. Reflection and transmission by a potential step and by a rectangular barrier. Use of WKB formula for the life-time calcuation in the alpha-decay problem.

2. **Quantum Mechanics II & Atomic Physics**

(a) **Quantum Mechanics II**

Particle in a three dimensional box, density of states, free electron theory of metals. The angular meomentum problem. The hydrogen atom. The spin half problem and properties of Pauli spin matrices.

(b) **Atomic Physics**

Stern-Gerlack experiment, electron spin, fine structure of hydrogen atom. L-S coupling, J-J coupling. Spectroscopic notation of atomic states. Zeeman effect. Frank-Condon principle and applications.

3. **Molecular Physics**

Elementary theory of rotational, vibratonal and electronic spectra of diatomic molecules. Raman effect and molecular structure. Laser Raman spectroscopy Importance of neutral hydrogen atom, molecular hydrogen and molecular hydrogen ion in astronomy Fluorescence and Phosphorescence. Elementary theory and applications of NMR. Elementary ideas about Lamb shift and its significance.

4. **Nuclear Physics**

Basic nuclear properties-size, binding energy, angular momentum, parity, magnetic moment. Semi-empirical mass formula and applications. Mass parabolas. Ground state of a deuteron magnetic moment and non-central forces. Meson theory of nuclear forces. Salient features of nuclear forces. Shell model of the nucleus-success and limitations. Violation of parity in beta decay. Gamma decay and internal conversion. Elementary ideas about Mossbauer spectroscopy. Q-value of nuclear reactions. Nuclear fission and fusion, energy production in stars. Nuclear reactors.

5. **Particle Physics & Solid State Physics**

(a) **Particle Physics**

Classification of elementary particles and their interactions. Conservation laws. Quark structure of hadrons. Field quanta of electroweak and strong interactions. Elementary ideas about Unification of Forces. Physics of neutrinos.

(b) **Solid State Physics**

Cubic crystal structure. Band theory of solids- conductors, insulators and semiconductors. Elements of superconductivity, Meissner effect, Josephson junctions and applications. Elementary ideas about high temperature superconductivity.

6. **Electronics**

Intrinsic and extrinsic semiconductors-p-n-p and n-p-n transistors.Amplifiers and oscillators. Op-amps. FET, JFET and MOSFET. Digital electronics-Boolean identities, De Morgan's laws, Logic gates and truth tables., Simple logic circuits. Thermistors, solar cells. Fundamentals of microprocessors and digital computers.

Political Science and International Relations - Optional

Political Theory and Indian Politics

1. Approaches to the study of political theory: historical, normative and empirical.

2. Theories of state: Social contract, Liberal, Neo-liberal, Marxist, communitarian, post-colonial.

3. State Sovereignty: Marxist and pluralistic theories; globalisation and the State.

4. Democracy and Human Rights: Democratic theory-classical and contemporary. Theories of Human Rights; Theories of Justice, Equality and Revolution, political obligation; New Social Movements.

5. Theories of Political Culture; Culture and politics in Third World countries.

6. Theories of Political Economy-Classical and contemporary.

7. Political Ideologies: Nature of Ideology; Liberalism, Socialism, Marxism, Fascism, Gandhism and Anarchism.

8. Theories of Power and Hegemony: Pareto, Mosca, Mitchels, C. Wright Mills, Weber, Gramsci, Hannah Arendt.

9. Indian Political Thought: Manu, Kautilya M.N. Roy Gandhi Ambedkar and E V Ramswami Naicker.

10. Political Thought: Plato, Aristotle, Machiavelli, Hobbes, J S Mill, Hegel and Marx, Lenin, Rosa Luxemberg and Mao Zedong.

Indian Government and Politics

1. Indian Nationalism: Dadabhai Naoroji, Tilak, Savarkar, Gandhi, Jayaprakash Narain, Nehru, Subhas Bose, Ambedkar, Ram Manohar Lohia.

2. Nature and struggle of Indian freedom struggle : From constitutionalism to Mass Satyagraha, Revolutionary movements Non Co-operation, Civil disobedience and Quit India, Indian Naval uprising, Indian National Army; role of women in freedom struggle.

3. Socio- economic dimensions of the nationalist movement: The communal question and the demand for partition; backward caste movements, Trade union and Peasant movements, Civil rights movement.

4. Landmarks in Constitutional Development during British Rule: Morley-Minto Reforms; Montagu-Chelmsford Reforms; Simon Commission; Government of India Act, 1935; Cripps Mission : Indian Independence Act, 1947.

5. Salient Features of the Indian Constitution: The Preamble, Fundamental Rights and Duties, Directive Principles; federalism, parliamentary system; amending procedures; judicial review.

6. The Executive System in theory and practice: President, Prime Minister and the Council of Ministers; Governor, Chief Minister and the State Council of Ministers. The Bureaucracy.

7. Role and function of the Parliament and Parlimentary Committee-Lok Sabha and Rajya Sabha; changing socio economic profile.

8. The Supreme Court and the High Courts; Judicial Activism; PIL.

9. Statutory institutions/commis sions-UPSC, Election Commission, Comptroller and Auditor General, Backward Classes Commission, National Commission for women; National Human Rights Commission; Minorities Commission.

10. Party system : ideology and social base of parties; fragmentation and regionalisation. Pressure groups; patterns of coalition politics; trends in electoral behaviour.

11. Class, caste, ethnicity and gender in Indian politics; politics of regionalism, communalism, backward class and Dalit movements, Tribal people movements, struggle for gender justice.

12. Planning and Economic Development : Role of the Planning Commission; Planning in the era of liberalisation; political dimensions of economic reforms.

13. Grassroots democracy : Panchayati Raj and municipal government; significance of 73rd and 74th Amendements. Grass root movement and women's empowerment.

Comparative Politics and International Relations-Comparative Analysis and International Politics

1. Approaches to the study of comparative politics : traditional approaches; political economy, political sociology or political system approaches; Nature of political process in the Third World.

2. The Modern State : Evolution, the contemporary trends in the advanced industrial countries and the third world.

3. Development : Strategies and contemporary discourse.

4. Concepts of International politics : Power, national interest, balance of power, national security, collective security and peace.

5. Theories of International politics Marxist, Realist, Systems, Decision-making and Game Theory.

6. Determinants of foreign policy : Domestic compulsions, geopolitics, geoeconomics and global order.

7. Origin and contemporary relevance of the Cold War, nature of the post-cold war global order.

8. Major issues of world politics : Cuban Missile Crisis; Vietnam War, Oil Crisis, Afghan Civil War, Gulf War, Collapse of the Soviet Union, Yugoslav Crisis.

9. Non-alignment : Concept and movement; Third World Movements for global justice, Non-alignment in the post cold war era.

10. The evolution of the international economic system-from Bretton woods to WTO, the North-South dimension.

11. International organisations UN and its specialized agencies : International Court of Justice; ILO, UNICEF, WHO UNESCO.

12. Regional, organizations such as the ASEAN, APEC, EU, SAARC, NAFTA

13. Contemporary Global Concerns : Democracy, Human Rights, Ecology, Gender Justice, Global commons, Communication.

India and the World

1. Indian Foreign Policy : Historical origins, determinants; the institutions of policy-making; continuity and change.

2. India and the Non-Alignment Movement : Evolution and contemporary relevance. Socio- political basis of non-alignment-domestic and global.

3. Major issues in Indian foreign policy : Sino-Indian Border War (1962); Indo-Pakistan War (1971) and the liberation of Bangladesh; IPKF in Sri Lanka; India as military nuclear power (1998).

4. Conflict and co-operation in South Asia : India's relations with Pakistan, Sri Lanka, Bangladesh, Nepal. Regional co-operation and SAARC. Kashmir question in India's foreign policy.

5. India's relation with Africa and Latin America.

6. India and South East Asia; ASEAN.

7. India and the major powers : USA, EU, China, Japan and Russia.

8. India and the UN System : India's role in UN Peace Keeping and global disarmament.

9. India and the emerging international economic order; multilateral agencies-WTO, IMF, IBRD, ADB.

10. India and the question of nuclear weapons : NPT and CTBT.

Psychology – Optional

Foundations of Psychology

1. Introduction : Psychology as a Science : Definitions and perspective. Psychology in relation to other social and natural sciences. Use of interdiciplinary approach.

2. **Methods of Psychology :** Characteristics and components of methods in psychology (induction, deduction and introspection). Observation, Survey, Laboratory and field experiments. Clinical and Case study. Experimental and quasi experimental methods.

3. **Research methods and quantitative analysis** : Major steps in psychological research (problem statement, hypothesis formulation, research design, sampling, tools of data collection, analysis and interpretation and report writing). Fundamental versus applied research. Methods of data collection (interview, observation, questionnaire and case study). Research Designs (Ex-post facto and experimental). Application of statistical techniques (t-test, one-way ANOVA correlation and regression and chi-square tests).

4. **Development of Human Behaviour** : The nature, origin and development. Role of genetic and environmental factors in determining human behaviour. Influence of cultural factors and socialisation. Life span development-the critical periods and their handling, Mastery of the developmental tasks. Influence of child rearing practices and its impact on the growth and development of the individual, concept of national character.

5. **Attention and perception :** Attention - factors, influencing attention including set and characteristics of stimulus. Sensation-concepts of threshold, absolute and difference thresholds, signal detection and vigilance. Definition and concept of perception, biological factors in perception. Perceptual organisation-influence of past experiences, Perceptual defence-factors influencing. Space and depth perception, size estimation and perceptual readiness.

6. **Learning :** Concepts and theories of learning (Pavlov, Skimer and Piaget). The processes of extinction, discrimination and generalisation. Programmed learning, probability learning, self instructional learning, concepts, types and the schedules of reinforcement. Modelling and social learning.

7. **Memory :** Concepts and definition of memory and forgetting, 7+/-2 concept and clumking Encoding, storage and retrieval. Factors influencing retention and foregetting. Theories of forgetting (Repression, Decay and Interference theories). The concept of reminiscence.

8. **Thinking and Problem Solving :** Concept formation processes. Reasoning and problem solving. Creative thinking and fostering creativity. Information processing. Decision making and judgment.

9. **Intelligence and Aptitude :** Concept and definition of Intelligence and aptitude, Nature and theories of intelligence. Measurement of Intelligence and aptitude Concepts and measurement of emotional and multiple intelligence.

10. **Motivation and Emotion :** Definition and concepts. Theories and physiological basis of motivation and emotion. Measurement of motivation and emotion Motivation and emotion-their effects on behaviour.

11. **Personality :** Concept and definition of personality. Theories of personality (psychoanalytical, socio-cultural, interpersonal and developmental, humanistic, behaviouristic, trait and type approaches). Measurement of personality (projective tests, pencil-paper test). The Indian approach to Personality. Training for personality development.

12. **Language and Communication :** Human language-properties, structure and linguistic hierarchy, Language acquisition-predisposition, critical period hypothesis. Theories of language development (Skinner, Chomsky), Process and types of communication. Effective communication and training.

13. **Attitudes, Values and Interests :** Definitions, concepts of attitudes, values and interests. Components ofattitudes, values and interests. Formation and maintenance of attitudes. Measurement of attitudes, values and interests. Theories of attitudes, and attitudes changes, strategies for fostering values.

14. **Recent Trends :** Computer application in the Psychological laboratory and psychological testing. Artificial Intelligence. Psychocybernetics. Study of consciousness-sleep-wake schedules; dreams, stimulus deprivation, meditation, hypnotic/drug induced states. Extrasensory perception. Intersensory perception Simulation studies.

I

Psychology : Issues and Applications

1. **Psychological Measurement of Individual Diference :** The nature of individual differences. Characteristics and construction of standardized psychological tests. Types of psychological tests. Use, misuse and limitation of psychological tests. Ethical issues in the use of psychological tests.

2. **Well being and Mental Disorders :** Concept of health, positive health, well being and ill health. Mental disorders (Anxiety disorders, mood disorders, schizophernia and delusional disorders; personality disorders, substance abuse disorders). Causal factors in mental disorders. Factors influencing positive health, well being, life style and quality of life.

3. **Therapeutic Approaches :** Psychody-namic therapies. Behaviour therapies. Client centered therapy. Cognitive therapies. Indigenous therapies (Yoga, Reiki, Meditation) Biofeedback therapy. Prevention and rehabilitation of the mentally ill.

4. **Work Psychology and Organisational Behaviour :** Personnel selection and training. Use of Psychological tests in the industry. Training and human resource development. Theories of work motivation. Leadership and participatory management. Advertising and marketing.

5. **Application of Psychology to Educational Field :** Psychological principles underlying effective teaching-learning process.Learning styles Gifted, retarded, learning disabled and their training. Training for improving memory and better academic achievement. Personality development and value education, Educational, vocational guidance and Career counselling. Use of Psychological tests in educational institutions.

6. **Communty Psychology :** Definition and concept of Community Psychology. Role of community psychologists in social change. Use of small groups in social action. Arousing community consciousness and action for handling social problems. Group decision making and leadership for social change.

7. **Rehabilitation Psychology :** Primary, secondary and tertiary prevention programmes-role of psychologists. Organising of services for rehabilitation of physically, mentally and socially challenged persons including old persons. Rehabilitation of persons suffering from substance abuse, juvenile delinquency, criminal behaviours. Rehabilitation of victims of violence. Rehabiliation of HIV/.AIDS victims.

8. **Application of Psychology to disadvantaged groups :** The concepts of disadvantaged, deprivation and socially deprived. Social, physical, cultural and economic consequences of disadvantaged and deprived groups. Educating and motivating the disadvantaged towards development.

9. **Psychological and the problem of social integration :** The concept of social integration. The problem of caste, class, religion and language conflicts and prejudice. Nature and manifestation of prejudice between the ingroup and outgroup. Casual factors of such conflicts and prejudices. Psychological strategies for handling the conflicts and prejudices. Measures to achieve social integration.

10. **Application of psychology in Information Technology and Mass media :** The present scenario of information technology and the mass media boom and the role of psychologists. Selection and training of psychology professionals to work in the field of IT and mass media. Distance learning through IT and mass media. Entrepre neurship through e-commerce. Multilevel marketing. Impact of TV and fostering value through IT and mass media. Psychological consequences of recent developments in Information Technology.

11. **Application of Psychology in the field of Defence :** The concept of Military psychology, Aviation psychology and Psychological warfare Role of Military psychologists in the defence. Selection, recruitment and training of personnel.

Facilitating the process of adjustment of personnel to military life-Role of Counselling. Devising Psychological tests for defence personnel. Psychological disorders due to war. Human engineering in Defence.

12. **Psychology and Economic development :** Achievement motivation and economic development. Characteristics of entrepreneurial behavior. Motivating and Training people for entrepreneurship and economic development. Women Entrepreneurs. Consumer rights and consumer courts.

13. **Application of psychology to environment and related fields :** Environmental psychology-effects of noise, pollution and crowding. Population psychology-psychological consequences of population explosion and high population density. Motivating for small family norms. Impact of rapid scientific and technological growth on degradation of environment.

14. **Other applications of psychology :** Sports psychology-improving performance of sports, personnel, psychology and understanding of political behaviour. Voting behaviours. Psychology of corruption and strategies to deal with Psychology of terrorism.

Public Administration – Optional

Administrative theory

I **Introduction :** Meaning, scope and significance of Public Administration, Public and Private Administration, Wilson's vision of Public Administration, Evolution of the discipline and its present status. New Public Administration. Public choice approach and New Public Management perspective. Features of Entrepreneurial Government, Good Governance : concept and application.

II Theories of Administration : Nature and typologies; Scientific Management (Taylor and the Scientific Management Movement), Classical Theory (Fayol, Urwick, Gulick and others), Bureaucratic Theory. (Marxist view, Weber's model and its critique, post-Weberian developments.) Ideas of Mary Parker Follett and (C.I. Barnard) Human Relations School (Elton Mayo and and others). Behavioral Approach to Organizational Analysis. Participative Management; (McGregor, Likert and others). The Systems Approach; Open and closed systems.

III Structure of public organisations : Typologies of Political Executive and their functions. Forms of public organizations : Ministries and Departments : Corporations; Companies, Boards and Commissions; Ad hoc and Advisory bodies. Headquarters and field relationships.

IV Administrative Behaviour : Decision making with special reference to Herbert Simon, Theories of Leadership, Communication, Morale, Motivation (Maslow and Herzberg.)

V Accountability and Control : Concepts of Accountability and Control; Legislative Executive and Judicial Control over Administration. Citizen and Administration, Role of civil society, people's participation, Right to information. Administrative corruption, machinery for redressal of citizens' grievances. Citizens Charter.

VI Administrative Law : Meaning and significance. Delegated Legislation : Types, Advantages, Limitations, Safeguards, Administrative Tribunals : limitations and methods of ensuring effectiveness.

VII **Administrative Reforms :** Meaning, process and obstacles. Techniques of administrative improvement : O and M; Work Study and Work Management, Information Technology.

VIII **Comparative Public Administration :** Meaning, nature and scope. Models of Comparative Public Administration : Bureaucratic and ecological.

IX **Development Administration :** Origin and purpose, Rigg's Prismatic-Sala Model; Bureaucracy and Development; Changing profile of Development Administration; new directions in people's self development and empowerment.

X **Public Policy :** Relevance of Policy making in Public Administration. Model of Policy-making Sectoral policies (e.g. Energy, Industries Education and Transport Policies) Process of Policy formulation, problems of implementation, feed-back and evaluation.

XI **Personnel Administration :** Objectives of Personnel Administration. Importance of human resource development. Recruitment, training, career development, position classification, discipline, Performance Appraisal, Promotion, Pay and Service Conditions; employer- employee relations, grievance redressal mechanism integrity and code of conduct.

XII **Financial administration :** Monetary and fiscal policies. Resource mobilisation : tax and non-tax sources. Public borrowings and public debt. Concepts and types of budget. Preparation and execution of the budget. Deficit financing Performance budgeting. Legislative control, Accounts and Audit.

Indian Administration

1. **Evolution of Indian Administration** Kautilya, Mughal period, British legacy.

2. **Constitutional framework** value premises of the Constitution, Parliamentary democracy, federalism, Planning. Human Rights : National Human Rights Commission.

3. **Union Government and Administration** President Prime Minister, Council of Ministers, Cabinet committees, Cabinet Secretariat, Prime Minister's Office, Central Secretariat, Ministries and Departments, Advisory Bodies, Boards and Commissions, Field Organizations.

4. **State Government and Administration–**Governor, Chief Minsiter, Council of Ministers, Chief Secretary, State Secretariat Directorates.

5. **District Administration** Changing role of the District Collector : Law and Order and Development Management. Relationship with functional departments. District administration and the Panchayati Raj institutions. Role and functions of the Sub-Divisional Officer.

6. **Local Government :** Panchayati Raj and Urban Local Government. Structures, Functions, finances. Main features of 73rd and 74th Constitutional Amendements : Problems of implementation. Major rural and urban development programmes and their management.

7. **Public Sector :** Forms of public undertakings. Their contribution to the economy; problems of autonomy and accountability. Changing role of the Public Sector in the context of liberalisation.

8 **Public Services :** All India Services Constitutional position , role and functions. Central Services : nature and functions. Union Public Service Commission. State Services and the State Public Service Commissions. Training in the changing context of governance.

9. **Control of Public Expenditure.** Parliamentary control Estimates Committee, Public Accounts Committee, Committee on Public Undertakings, Office of the Comptroller and Auditor General of India, Role of the Finance Ministry in monetary and fiscal policy area, co-ordination and economy in expenditure.

10. **Administrative Reforms :** Reforms since independence. Reports of the Administrative Reforms Commission, Problems of implementation.

11. **Machinery for Planning :** Role, composition and review of functions of the Planning Commission; Role of the National Development Council. Process of Plan formulation at Union and State levels. Decentralized planning.

12. **Administration of Law and Order :** Role of Central and State Agencies in maintenance of law and order. Criminalisation of politics and administration.

13. **Welfare Administration :** Machinery for welfare administration at the national and state levels. Central Social Welfare Board and the State, Social Welfare Boards. Special organizations for the welfare of the Scheduled Castes and Scheduled Tribes. Welfare Programmes for women and children. Problems of child labour. Role of civil society.

14. **Major issues in Indian Administration :** problems of Centre-State Relations; Relationship between political and permanent Executives. Values in Public Service and Administrative Culture. Lok Pal and Lok Ayuktas. Development and environmental issues. Impact of information Technology on Public Administration. Indian Administration and Globalisation.

Sociology – Optional

General Sociology/Foundations of Sociology/Fundamentals of Sociology

1. Sociology-The Discipline :

Sociology as a science and as an interpretative discipline; impact of industrial and French Revolution on the emergence of sociology; sociology and its relationship with history, economics, political science, psychology and anthropology.

2. Scientific Study of Social Phenomena : Problem of objectivity and value neutrality; issue of measurement in social science; elements of scientific method-concepts, theory and fact, hypothesis; research designs-descriptive, exploratory and experimental

3. Techniques of data collection and analysis :

Participant and quasi-participant observation; interview, questionnaire and schedule case study, sampling-size, reliability and validity, scaling techniques-social distance and Likert scale.

4. **Pioneering contributions to Sociology:**

a) Karl Marx : Historical materialism, mode of production, alienation and class struggle.

b) Emile Durkheim : Division of labour, social fact, religion and society.

c) Max Weber : Social action, ideal types, authority, bureaucracy, protestant ethic and the spirit of capitalism.

d) Talcott Parsons : Social system, pattern variables.

e) Robert K. Merton : Latent and manifest functions, anomie, conformity and deviance, reference groups.

5. Marriage and Family :

Types and forms of marriage; family-structure and function; personality and socialization; Social control; family, lineage, descent and property; changing structure of family marriage and sex roles in modern society; divorce and its implications; gender issues; role conflicts.

6. Social Stratification :

Concepts-hierarchy, inequality and stratification; theories of stratification-Marx, Davis and Moore and Melvin Tumin’s critique; forms and functions; class-different

conceptions of class; class-in-itself and class-for-itself; caste and class; caste as a class.

7. Social Mobility :

Types of mobility-open and closed models; intra-and inter-generational mobility; vertical and horizontal mobility; social mobility and social change.

8. Economic System :

Sociological dimensions of economic life; the impact of economic processes on the larger society; social aspects of division of labour and types of exchange; features of pre-industrial and industrial economic system; industrialisation and social change; social determinants of economic development.

9. Political System :

The nature of power-personal power, community power, power of the elite, class power, organisational power, power of the un-organised masses; authority and legitimacy; pressure groups and political parties; voting behaviour; modes of political participation-democratic and authoritarian forms.

10. Educational System :

Education and Culture; equality of educational opportunity; social aspects of mass education; problems of universalisation of primary education; role of community and state intervention in education; education as an instrument of social control and social change; education and modernisation.

11. Religion :

Origins of religious beliefs in pre-modern socieites; the sacred and the profane; social functions and dysfunctions of religion; monistic and pluralistic religion; organised and unorganised religions; semitism and antisemitism; religion, sect and cults; magic, religion and science.

12. Science & Technology :

Ethos of science; social responsibility of science; social control of science; social consequences of science and technology; technology and social change.

13. Social Movements :

Concepts of social movements; genesis of social movements; ideology and social movement; social movement and social change; types of social movements.

14. Social change and Development :

Continuity and change as fact and as value; theories of social change-Marx, Parsons and Sorokin; direted social change; social policy and social development.

Study of Indian Society

1. Historical Moorings of the Indian Society :

Traditional Hindu social organisation; socio-cultural dynymics through the ages; impact of Buddhism, Islam, and the West, factors in continuity and change.

2. Caste System :

Origin of the caste system; cultural and structural views about caste; mobility in caste; caste among Muslims and Christians; change and persistence of caste in modern India; issues of equality and social justice; views of Gandhi and Ambedkar on caste; caste on and Indian polity; Backward Classes Movement; Mandal Commission Report and issues of social backwardness and social justice; emergence of Dalit consciousness.

3. Class Structure :

Class structure in India, agrarian and industrial class structure; emergence ofmiddle class; emergence of classes among tribes; elite formation in India.

4. Marriage, Family and Kinship:

Marriage among different ethnic groups, its changing trends and its future; family-its structural and functional aspects-its changing forms; regional variations in kinship systems and its socio-cultural correlates; impact of legislation and socio-economic change on marriage and family; generation gap.

5. Agrarian Social Structure :

Peasant society and agrarian systems; land tenure systems-historical perspectives, social consequences of land reforms and green revolution; feudalism-semi-feudalism debates; emerging agrarian class structure; agrarian unrest.

6. Industry and Society :

Path of industrialisation, occupational diversification, trade unions and human relations; market economy and its social consequences; economic reforms liberalisation, privatisation and globalisation.

7. Political Processes :

Working of the democratic political system in a traditional society; political parties and their social base; social structural origins of political elites and their orientations; regionalism, pluralism and national unity; decentralisation of power; panchayati raj and nagarpalikas and 73rd and 74th constitutional amendments.

8. Education :

Directive Principles of State Policy and primary education; education; educational inequality and change; education and social mobility; the role of community and state intervention in education; universalisation of primary education; Total Literacy Campaigns; educational problems of disadvantages groups.

9. Religion and Society :

Size, growth and regional distribution of different religious groups; educational levels of different groups; problems of religious minorities; communal tensions; secularism; conversions; religious fundamentalism.

10. Tribal Societies :

Distinctive features of tribal communities and their geographical spread; problems of tribal communities-land alienation, poverty, indebetedness, health and nutrition, education; tribal development efforts after independence; tribal policy-isolation, assimilation and integration; issues of tribal identity.

11. Population Dynamics :

Population size, growth, composition and distribution; components of population growth; birth rate, death rate and migration; determinants and consequences of population growth; issues of age at marriage, sex ratio, infant mortality rate; population policy and family welfare programmes.

12. Dimensions of Development :

Strategy and ideology of planning; poverty, indebtedness and bonded labour; strategies of rural development-poverty alleviation programmes; environment, housing, slums, and unemployment; programmes for urban development.

13. Social Change :

Endogenous and exogenous sources of change and resistance to change; processes of change-sanskritisation and modernisation; agents of change-mass media, education and communication; problems of change and modernisation; structural contradictions and breakdowns.

14. Social Movements :

Reform Movements : Arya Samaj, Satya Sadhak Samaj, Sri Narayanguru Dharma Paripalana Sabha, and Ram Krishna Mission.

Peasant movements-Kisan Sabha, Telengana, Naxalbari.

Backward Castes Movement : Self-respect Movement, backward castes mobilisation in North India.

15. Women and society :

Demographic profile of women; special problems-dowry, atrocities, discrimination; existing programmes for women and their impact. Situational analysis of children; child welfare programmes.

16. Social Problems :

Prostitution, AIDS, alcoholism, drug addiction, corruption.

Statistics – Optional

Probability :

Sample space and events, probability measure and probability space, random variable as a measurable function, distribution function of a random variable, discrete and continuous-type random variable probability mass function, probability density function, vector-valued random variable, marginal and conditional distributions, stochastic independence of events and of random variables, expectation and moments of a random variable, conditional expectation, convergence of a sequence of random variable in distribution, in probability, in p-th mean and almost everywhere, their criteria and inter-relations, Borel-Cantelli lemma, Chebyshev's and Khinchine's weak laws of large numbers, strong law of large numbers and kolmogorov's theorems, Glivenko-Cantelli theorem, probability generating function, characteristic function, inversion theorem, Laplace transform, related uniqueness and continuity theorems, determination of distribution by its moments. Linderberg and Levy forms of central limit theorem, standard discrete and continuous probability distributions, their inter-relations and limiting cases, simple properties of finite Markov chains.

Statistical Inference

Consistency, unbiasedness, efficiency, sufficiency, minimal sufficiency, completeness, ancillary statistic, factorization theorem, exponential family of distribution and its properties, uniformly minimum variance unbiased (UMVU) estimation, Rao-Blackwell and Lehmann-Scheffe theorems, Cramer-Rao inequality for single and several-parameter family of distributions, minimum variance bound estimator and its properties, modifications and extensions of Cramer-Rao inequality, Chapman-Robbins inequality, Bhattacharyya's bounds, estimation by methods of moments, maximum likelihood, least squares, minimum chi-square and modified minimum chi-square, properties of maximum likelihood and other estimators, idea of asymptotic efficiency, idea of prior and posterior distributions, Bayes estimators.

Non-randomised and randomised tests, critical function, MP tests, Neyman-Pearson lemma, UMP tests, monotone likelihood ratio, generalised Neyman-Pearson lemma,

similar and unbiased tests, UMPU tests for single and several-parameter families of distributions, likelihood rotates and its large sample properties, chi-square goodness of fit test and its asymptotic distribution.

Confidence bounds and its relation with tests, uniformly most accurate (UMA) and UMA unbiased confidence bounds.

Kolmogorov's test for goodness of fit and its consistency, sign test and its optimality. wilcoxon signed-ranks test and its consistency, Kolmogorov-Smirnov two-sample test, run test, Wilcoxon-Mann-Whitney test and median test, their consistency and asymptotic normality.

Wald's SPRT and its properties, OC and ASN functions, Wald's fundamental identity, sequential estimation.

Linear Inference and Multivariate Analysis

Linear statistical models', theory of least squares and analysis of variance, Gauss-Markoff theory, normal equations, least squares estimates and their precision, test of signficance and interval estimates based on least squares theory in one-way, two-way and three-way classified data, regression analysis, linear regression, curvilinear regression and orthogonal polynomials, multiple regression, multiple and partial correlations, regression diagnostics and sensitivity analysis, calibration problems, estimation of variance and covariance components, MINQUE theory, multivariate normal distribution, Mahalanobis;' D2 and Hotelling's T2 statistics and their applications and properties, discrimi nant analysis, canonical correlatons, one-way MANOVA, principal component analysis, elements of factor analysis.

Sampling Theory and Design of Experiments

An outline of fixed-population and super-population approaches, distinctive features of finite population sampling, probability sampling designs, simple random sampling with and without replacement, stratified random sampling, systematic sampling and its efficacy for structural populations, cluster sampling, two-stage and multi-stage sampling, ratio and regression, methods of estimation involving one or more auxiliary variables, two-phase sampling, probability proportional to size sampling with and without replacement, the Hansen-Hurwitz and the Horvitz-Thompson estimators, non-negative variance estimation with reference to the Horvitz-Thompson estimator, non-sampling errors, Warner's randomised response technique for sensitive characteristics.

Fixed effects model (two-way classification) random and mixed effects models (two-way classification per cell), CRD, RBD, LSD and their analyses, incomplete block designs, concepts of orthogonality and balance, BIBD, missing plot technique, factorial designs : 2n, 32 and 33, confounding in factorial experiments, split-plot and simple lattice designs.

I. Industrial Statistics

Process and product control, general theory of control charts, different types of control charts for variables and attributes, X, R, s, p, np and c charts, cumulative sum chart, V-mask, single, double, multiple and sequential sampling plans for attributes, OC, ASN, AOQ and ATI curves, concepts of producer's and consumer's risks, AQL, LTPD and AOQL, sampling plans for variables, use of Dodge-Romig and Military Standard tables.

Concepts of reliability, maintainability and availability, reliability of series and parallel systems and other simple configurations, renewal density and renewal function, survival models (exponential), Weibull, lognormal, Rayleigh, and bath-tub), different types of redundancy and use of redundancy in reliability improvement,

problems in life-testing, censored and truncated experiments for exponential models.

II. Optimization Techniques

Different, types of models in Operational Research, their construction and general methods of solution, simulation and Monte-Carlo methods, the structure and formulation of linear programming (LP) problem, simple LP model and its graphical solution, the simplex procedure, the two-phase method and the M-technique with artificial variables, the duality theory of LP and its economic interpretation, sensitivity analysis, transportation and assignment problems, rectangular games, two-person zero-sum games, methods of solution (graphical and algerbraic).

Replacement of failing or deteriorating items, group and individual replacement policies, concept of scientific inventory management and analytical structure of inventory problems, simple models with deterministic and stochastic demand with and without lead time, storage models with particular reference to dam type.

Homogeneous discrete-time Markov chains, transition probability matrix, classification of states and ergodic theorems, homogeneous continous-time Markov chains, Poisson process, elements of queueing theory, M/M/1, M/M/K, G/M/1 and M/G/1 queues.

Solution of statistical problems on computers using well known statistical software packages like SPSS.

III. Quantitative Economics and Official Statistics

Determination of trend, seasonal and cyclical components, Box-Jenkins method, tests for stationery of series, ARIMA models and determination of orders of autoregressive and moving average components, forecasting.

Commonly used index numbers-Laspeyre's, Paashe's and Fisher's ideal index numbers, chain-base index number uses and limitations of index numbers, index number of wholesale prices, consumer price index number, index numbers of agricultural and industrial production, test for index numbers like proportionality test, time-reversal test, factor-reversal test, circular test and dimensional invariance test.

General linear model, ordinary least squares and generalised least squires methods of estimation, problem of multicollinearlity, consequences and solutions of multicollinearity, autocorrelation and its consequeces, heteroscedasticity of disturbances and its testing, test for independe of disturbances, Zellner's seemingly unrelated regression equation model and its estimation, concept of structure and model for simulaneous equations, problem of identification-rank and order conditions of identifiability, two-stage least squares method of estimation.

Present official statistical system in India relating to population, agriculture, industrial production, trade and prices, methods of collection of official statistics, their reliability and limitation and the principal publications containing such statistics, various official agencies responsible for data collection and their main functions.

IV. Demography and Psychometry

Demographic data from census, registration, NSS and other surveys, and their limitation and uses, definition, construction and uses of vital rates and ratios, measures of fertility, reproduction rates, morbidity rate, standardized death rate, complete and abridged life tables, construction of life tables from vital statistics and census returns, uses of life tables, logistic and other population growth curves, fifting a logistic curve, population projection, stable population quasi-stable population techniques in estimation of demographic parameters, morbidity and its measurement, standard classification by cause of death, health surveys and use of hospital statistics.

Methods of standardisation of scales and tests, Z-scores, standard scores, T-scores, percentile scores, intelligence quotient and its measurement and uses, validity of test scores and its determination, use of factor analysis and path analysis in psychometry.

Zoology – Optional

1. **Non-chordata and chordata :**

(a) Classfication and relationship of varous phyla upto sub-classes; Acoelomata and Coelomata; Protostomes and Deuterostomes, Bilateralia and Radiata; Status of Protista, Parazoa, Onychophora and Hemichordata; Symmetry.

(b) *Protozoa :* Locomotion, nutrition, reproduction; evolution of sex; General features and life history of Paramaecium, Monocystis, Plasmodium, and Leishmania.

(c) *Porifera :* Skeleton, canal system and reproduction.

(d) *Coelenterata :* Polymorphism, defensive structures and their mechanism; coral reefs and their formation; metagenesis; general features and life history of Obelia and Aurelia.

(e) *Platyhelminthes :* Parasitic adaptation; general features and life history of Fasciola and Taenia and their relation to man.

(f) *Nemathelminthes :* General features, life history and parasitic adaptation of *Ascaris;* nemathelminths in relation to man.

(g) *Annelida :* Coelom and metamerism; modes of life in polychaetes; general features and life history of nereis (*Neanthes*), earthworm (*Pheretima*) and leach (*Hirudinaria*).

(h) *Arthropoda :* Larval forms and parasitism in Crustacea; vision and respiration in arthropods (prawn, cockroach and scorpion); modification of mouth parts in insects (cockroach, mosquito, housefly, honey bee and butterfly); metamorphosis in insects and its hormonal regulation; social organization in insects (termites and honey bees).

(i) *Mollusca :* Feeding, respiration, locomotion, shell diversiy; general features and life history of Lamellidens, Pila and Sepia, torsion and detorsion in gastropods.

(j) *Echinodermata :* Feeding, respiration, locomotion larval forms; general features and life history of Asterias.

(k) *Protochordata :* Origin of chordates; general features and life history of Branchiostoma and Herdamania.

(l) *Pisces :* Scales, respiration, locomotion, migration.

(m) *Amphibia :* Origin of tetrapods; parental care, paedomorphosis.

(n) *Reptilia :* Origin of reptiles; skull types; status of Sphenodon and crocidiles.

(o) *Aves :* Origin of birds; flight adaptation, migration.

(p) *Mammalia :* Origin of mammals; denitition; general features of egg-laying mammals, pouched-mammals, aquatic mammals and primates; endocrine glands and other hormone producing structures (pituitary, thyroid, parathyroid, adrenal, pancreas, gonads) and their interrelationships.

(q) Comparative functional anatomy of various systems of vertebrates (integument and its derivatives, endoskeleton, locomotory organs, digestive system, respiratory system, circulatory system including heart and aortic arches; urino-genital system, brain and sense organs (eye and ear).

1. **Ecology :**

(a) Biosphere:Biogeochemical cycles, green-houses effect, ozone layer and its impact; ecological succession, biomes and ecotones.

(b) Population, characteristics, population dynamics, population stabilization.

(c) Conservation of natural resources- mineral mining, fisheries, aquaculture; forestry; grassland; wildlife (Project Tiger); susainable production in agriculture-integrated pest management.

(d) Environmental biodegradation; pollution and its impact on biosphere and its prevention.

II. **Ethology :**

(a) Behaviour : Sensory filtering, responsiveness, sign stimuli, learning, instinct, habituation, conditioning, imprinting.

(b) Role of hormones in drive; role of pheromones in alarm spreading; crypsis, predator detection, predator tactics, social behaviour in insects and primates; courtship (Drosophila, 3-spine stickleback and birds).

(c) Orientation, navigation, homing; biological rhythms; biological clock, tidal, seasonal and circadian rhythms.

(d) Methods of studying animal behaviour.

III. **Economic Zoology :**

(a) Apiculture, sericulture, lac culture, carp culture, pearl culture, prawn culture.

(b) Major infectious and communicable diseases (small pox, plague, malaria, tuberculosis, cholera and AIDS) their vectors, pathogens and prevention.

(c) Cattle and livestock diseases, their pathogens (helminths) and vectors (ticks, mites,Tabanus, Stomoxys)

(d) Pests of sugar cane (Pyrilla perpusiella), oil seed (Achaea janata) and rice (Sitophilus oryzae).

IV. **Biostatistics :**

Designing of experiments; null hypothesis; correlation, regression, distribution and measure of central tendency, chi square, student t-test, F-test (one-way & two-way F-test).

V. **Instrumental methods :**

(a) Spectrophotometry, flame photometry, Geiger-Muller counter, scintiliation counting.

(b) Electron microscopy (TEM, SEM).

I. **Cell Biology :**

(a) Structure and function of cell andits organelles(nucleus, plasma membrane, mitochondria, Golgi bodies, endoplasmic reticulum, ribosomes and lysosomes), cell division (mitosis and meiosis), mitotic spindle and mitotic apparatus, chromosome movement.

(b) Watson-Crick model of DNA, replication of DNA, protein synthesis, transcription and transcription factors.

II. **Genetics**

a) Gene structure and functions; genetic code.

(b) Sex chromosomes and sex determination in Drosophilla, nematodes and man.

(c) Mendel's laws of inheritance, recombination, linkage, linkage-maps, multiple alleles, cistron concept; genetics of blood groups.

(d) Mutations and mutagenesis : radiation and chemical.

(e) Cloning technology, plasmids and cosmids as vectors, transgenics, transposons, DNA sequence cloning and whole animal cloning (Principles and methodology).

(f) Regulation and gene expression in pro-and eu-karyotes.

(g) Signal transduction; pedigree-analysis; congenital diseases in man.

(h) Human genome mapping; DNA finger-printing.

III. **Evolution**

(a) Origin of life

(b) Natural selection, role of mutation in evolution, mimicry, variation, isolation, speciation.

(c) Fossils and fossilization; evolution of horse, elephant and man.

(d) Hardy-Weinberg Law, causes of change in gene frequency.

(e) Continental drift and distribution of animals.

IV. **Systematics**

(a) Zoological nomenclature; international code; cladistics.

I. **Biochemistry**

(a) Structure and role of carbohydrates, fats, lipids, proteins, aminoacids, nucleic acids; saturated and unsaturated fattyacids, cholesterol.

(b) Glycolysis and Krebs cycle, oxidation and reduction, oxidative phosphorylation; energy conservation and release, ATP, cyclic AMP-its structure and role.

(c) Hormone classification (steroid and peptide hormones), biosynthesis and function.

(d) Enzymes : types and mechanisms of action; immunoglobulin and immunity; vitamins and co-enzymes.

(e) Bioenergetics.

II **Physiology** (with special refernece ot mammals)

(a) Composition and constitutents of blood; blood groups and Rh factor in man; coagulation, factors and mechanism of coagulation; acid-base balance, thermo regulation.

(b) Oxygen and carbon dioxide transport; haemoglobin : constituents and role in regulation.

(c) Nutritive requirements; role of salivary glands, liver, pancreas and intestinal glands in digestion and absorption.

(d) Excretory products; nephron and regulation of urine formation; osmoregulation.

(e) Types of muscles, mechanism of contraction of skeletal muscles.

(f) Neuron, nerve impulse-its conduction and synaptic transmission; neurotransmitters.

(g) Vision, hearing and olfaction in man.

(h) Mechanism of hormone action.

(i) Physiology of reproduction, role of hormones and phermones.

III. **Developmental Biology**

(a) Differentiation from gamete to neurula stage; dedifferentiation; metaplasia, induction, morphogenesis and morphogen; fate maps of gastrulae in frog and chick; organogenesis of eye and heart, placenation in mammals.

(b) Role of cytoplasm in and genetic control of development; cell lineage; causation of metamorphosis in frog and insects; paedogenesia and neoteny; growth, degrowth and cell death; ageing; blastogenesis; regeneration; teratogenesis; neoplasia.

(c) Invasiveness of placenta; in vitro fertilization; embryo transfer, cloning.

(d) Baer's law; evo-devo concept.