महाराष्ट्र वनसेवा मुख्य परीक्षेची विषय-योजना व अभ्यासक्रम

(१) परीक्षेची विषय-योजना

प्रस्तुत मुख्य परीक्षा (१)लेखी परीक्षा (६०० गुण),(२) मौखिक व व्यक्तिमत्व चाचणी (७५ गुण) अशा दोन भागात घेण्यात येईल.

(१)**लेखी परीक्षा** (६०० **गुण**) :- प्रस्तुत लेखी परीक्षेमध्ये खाली नमूद केल्याप्रमाणे अनिवार्य विषयांच्या दोन व वैकल्पिक विषयांच्या **दोन** अशा एकूण चार प्रश्नपत्रिका असतील. त्यांचा तपशील पुढीलप्रमाणे राहील **:-**

प्रश्नपत्रिका क्रमांक	विषय	दर्जा	कालावधी	गुण	माध्यम	परीक्षेचे स्वरुप
पेपर-१ (अनिवार्य)	मराठी	उच्च माध्यमिक परीक्षेसमान	तीन तास	१००	मराठी	पारंपरिक
पेपर-२ (अनिवार्य)	इंग्रजी	उच्च माध्यमिक परीक्षेसमान	तीन तास	१००	इंग्रजी	पारंपरिक
पेपर-३	वैकल्पिक विषय-१	पदवी	तीन तास	२००	इंग्रजी	पारंपरिक
पेपर-४	वैकल्पिक विषय-२	पदवी	तीन तास	२००	इंग्रजी	पारंपरिक
		लेखी परीक्षेचे एकूण गुण		६००		

(अ) **अनिवार्य विषय** (२०० **गुण**) :- " पेपर -१ : मराठी " आणि " पेपर- २ : इंग्रजी " अशा दोन अनिवार्य पारंपरिक स्वरुपाच्या प्रश्नपत्रिका असतील.

(ब) **वैकल्पिक विषय** (४०० **गुण**) :- खालील (**क**) **मध्ये** नमूद केलेल्या निर्बंधित गटांच्या अधीन राहून पुढील यादीतून कोणतेही दोन वैकल्पिक विषय निवडण्याची मुभा असेल. या प्रत्येक वैकल्पिक विषयासाठी पारंपारिक स्वरुपाची, २०० गुणांची एकच प्रश्नपत्रिका असेल **:** -

(१) कृषि (२) वनस्पतीशास्त्र (३) रसायनशास्त्र (४) स्थापत्य अभियांत्रिकी (५) भूशास्त्र (६) कृषि अभियांत्रिकी (७) रासायनिक अभियांत्रिकी (८) गणित (९) यंत्र अभियांत्रिकी (१०) भौतिकशास्त्र (११) प्राणिशास्त्र (१२) सांख्यिकी (१३) वनशास्त्र (१४) उद्यानविद्या (१५) पशुसंवर्धन व पशुवैद्यकशास्त्र

(क) **वैकल्पिक विषयांचे निर्बंधित गट**: उमेदवारास खालील प्रत्येक निर्बंधित गटातून फक्त एकच विषय निवडण्याची परवानगी असेल **:-**

(१) कृषि/उद्यानविद्या /कृषि अभियांत्रिकी / पशुसंवर्धन व पशुवैद्यकशास्त्र (२) रसायनशास्त्र / रासायनिक अभियांत्रिकी (३) गणित / सांख्यिकी (४) स्थापत्य अभियांत्रिकी / यंत्र अभियांत्रिकी / कृषि अभियांत्रिकी / रासायनिक अभियांत्रिकी

(२) **मौखिक व व्यक्तिमत्व चाचणी** (७५ **गुण**) :- जे उमेदवार लेखी परीक्षेमध्ये अर्हताप्राप्त होतील अशाच उमेदवारांची प्रस्तुत चाचणी घेण्यात येईल व प्रस्तुत चाचणीसाठी फक्त ७५ गुण असतील.

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अनिवार्य विषयांचा अभ्यासक्रम
विषय : मराठी - अनिवार्य
(संकेतांक: ००१)

दर्जा : उच्च माध्यमिक शालांत परीक्षा
प्रश्नपत्रिका चे स्वरूप : पारंपरिक

एकूण गुण : १००
कालावधी : ३ तास

सूचना :प्रस्तुत प्रश्नपत्रिकेचा उद्देश उमेदवाराचे भाषिक ज्ञान, अभिव्यक्ती, आकलनक्षमता, लेखन आणि संवाद कौशल्याच्या जाणिवांचा स्तर पडताळणे हा आहे.

			गुण
१)	**लेखन** (**६० गुण**) :		
	अ)	**निबंध** (सुमारे ५०० शब्दांचा) वैचारिक / वर्णनात्मक / कल्पनापर / आत्मकथनपर आणि समकालीन ज्वलंत समस्या या प्रकारचे निबंध असतील, त्यापैकी एकच निबंध लिहिणे अपेक्षित आहे.	१५
	ब)	१) पत्रव्यवहार / अर्ज (मागणीपत्र / तक्रारपत्र / विनंतीपत्र)	०५
		२) अहवाल लेखन / वृत्तांत लेखन	०५
		३) पत्रकार परिषद (ऊर्जा, कृषी कर्ज, जलसिंचन इत्यादी समस्यांबाबत) किंवा नोकरीसाठी मुलाखत	०५
		४) निमंत्रण-पत्रिका अथवा कार्यक्रम-पत्रिका तयार करणे	०५
		५) शुभेच्छा / अभिनंदन पत्र	०५
		६) प्रसार माध्यमासाठी आवाहन / निवेदन तयार करणे	०५
		७) औपचारिक भाषणे तयार करणे. (स्वागत, निरोप, उद्घाटनपर व इतर)	०५
		८) **संवादकौशल्य :**	
		(**अ**) दोन व्यक्तींमधील संवाद	०५
		(**ब**) गटचर्चा /सभेचे कामकाज (पाणी प्रश्न, कृषी समस्या, कुटुंबकल्याण, ग्राम स्वच्छता इत्यादी)	०५
२)	**आकलन** (**२० गुण**) :		
	अ)	इंग्रजी उताऱ्याचे सुबोध मराठीत भाषांतर करणे	०५
	ब)	सारांश लेखन - १/३ शब्दात सारांश लेखन करून शीर्षक देणे	०५
	क)	प्रमाणित भाषेतील उताऱ्यावरील प्रश्नांची उत्तरे देणे	०५
	ड)	दिलेल्या उताऱ्यातील आशय सरळ व सोप्या भाषेत लिहिणे.	०५
३)	**व्याकरण** (**२० गुण**) :		
	अ)	शब्दांच्या जाती (शब्दांच्या जाती ओळखणे)	०५
	ब)	वाक्यप्रकार (मिश्र, संयुक्त, साधे / केवल)	०५
	क)	काळ (वर्तमान, भूत, भविष्य)	०५
	ड)	वाक्प्रचार व म्हणी	०३
	इ)	पारिभाषिक शब्द (इंग्रजी पारिभाषिक शब्दांना मराठी पर्यायी शब्द देणे)	०२

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Subject : English (Compulsory)
(Code No : 003)

Standard : H.S.C. **Total Marks** : 100

Nature of Paper : Conventional Type **Duration** : 3 Hours

1) **Essay :** The candidates are expected to write a narrative or a descriptive essay on one of the given topics in about 300 words. It is intended to judge the candidate's knowledge of the topic, manner of presentation and also competence in using correct English **(Marks : 15)**

2) **Letter writing :** The candidates will be asked to write two types of letters, i.e. an informal letter to parents/ to a friend and a formal letter – an official/ business letter or a letter to the editor of a newspaper on a given topic in about 100 words. The candidate will be judged for content, manner of presentation and observance of the formal requirements of letter writing. **(Marks : 10)**

3) **Communication Skills :** The candidates are expected to write on each of the following communicative activities (in about 100-150 words). The purpose is to judge the candidate's ability to communicate effectively in different contexts**:** **(Marks : 25)**

- **a)** **A report of** an event or a function or official work done.
- **b)** **A notice** or an appeal or a warning or a Press Release for the Media (Radio, T.V., Press).
- **c)** **(i) Dialogue writing :** A dialogue between two persons or an appeal or a discussion on a topical issue.
- **(ii) Speeches:** formal speeches–welcome/send-off/inaugural speech etc.

(d) An individual conversation with a group of people --

- **(1)** at a Job Interview.
- **(2)** at a Press Conference.
- **(3)** with a delegation
- **(4)** at a project site -- e.g.: (i) camps being constructed for cattle in a drought-affected area, (ii) temporary shelters being constructed for earthquake-affected people.
- **(5)** at a place where some problematic situation has occurred -- e.g.: natural calamities like floods, earthquakes etc.

(e) A Group Discussion, a Meeting, a Teleconference on a topical issue.

4) **Precis-writing :** A passage of about 300 words will be given for precis-writing. The candidates are expected to reduce the passage to one-third of its original length in their own words. The purpose of precis-writing is to judge the candidate's ability to comprehend, analyse and summarise the main ideas in the passage in their own words to one-third of the given number of words therein. **(Marks : 10)**

5) **Comprehension :** A passage of about 300 words will be given with a set of questions based thereon. The purpose of the activity is to assess the candidate's competence in understanding and answering questions based on the passage. **(Marks : 10)**

6) **Paraphrase of a Prose Passage :** A prose passage of about 300 words will be given to be paraphrased in order to judge the candidate's ability to understand, analyse and express clearly and in simple language the ideas in the passage in his/her own words. **(Marks : 10)**

7) **Grammar :** **(Marks : 20)**

i) Transformation of Sentences, ii) Correction of Sentences,
iii) Use of Tenses, iv) Punctuation, v) Word-formation,
vi) Use of Phrases.

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वैकल्पिक विषयांचा अभ्यासक्रम

AGRICULTURE (OPTIONAL)

(Code No:101)

Standard :- Degree
Medium :- English
Nature :- Conventional (Essay) type

Total Marks :- 200
Duration :- Three hours

SECTION - A

1) Agroecology 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. Aberrant weather conditions and their management. Environmental pollution and associated hazards to crops, animals and humans. Agro-meteorology advisory service and its role in crop production.

2) Cropping pattern in different agro-climatic zones of Maharashtra. Impact of high-yielding and short-duration varieties on shifts in cropping pattern. Concepts of multiple cropping, multistory, relay and inter-cropping and their importance. Modern concepts of organic farming, sustainable agriculture. Classification of weeds and their management. Designing of field experiments. Important features, scope and propagation of various types of forestry such as farm forestry, social forestry, agro-forestry and natural forests and medicinal and aromatic plants.

3) Soil-physical, chemical and biological properties. Processes and factors of soil formation. Mineral and organic constituents of soil and their role in maintaining soil productivity. Essential plant nutrients and other beneficial elements in soils and plants Manures and fertilizers. Principles of soil fertility and its evaluation for judicious fertilizer use, integrated nutrient management. Problem soils and their reclamation methods.

4) Soil conservation planning on watershed basis. Erosion and run-off management in hilly, foot hills and valley lands; processes and factors affecting them. Dryland agriculture and its problems. Water-use efficiency in relation to crop production, criteria for scheduling irrigation, ways and means of reducing run-off losses of irrigation water. Drip and sprinkler irrigation. Drainage of water-logged soils, effect of industrial effluents on soil and water. Status of farm mechanisation in Maharashtra.

SECTION - B

1) Plant cell-structure, function and division Laws of heredity, their significance in plant breeding. Polyploidy, Mutation and their role in crop improvement. Variation, components of variation. Heritability, sterility and incompatibility, classification and their application in crop improvement. Cytoplasmic inheritance. Modes of reproduction, selfing and crossing techniques. Origin and evolution of crop plants, centres of origin, law of homologous series. Crop genetic resources- conservation and utilization. Pure-line selection, pedigree, mass and recurrent selection, combining ability, its significance in plant breeding. Hybrid vigour and its exploitation, backcross method of breeding, breeding for biotic and abiotic stress resistance, role of interspecific and intergeneric hybridization. Biotechnology and its role in plant broading, tissue culture, genetic engineering, transgenic plants.

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

3) Crop Physiology and its significance in agriculture. Absorption and translocation of water, transpiration and water economy. Photosynthesis-modern concepts and factors affecting the process, aerobic and anaerobic respiration. 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.

4) Status of fruit, vegetable and flower crops in Maharashtra. Climatic requirements and cultivation of major fruit, vegetable and flower plants, package of practices and their scientific basis. Principal methods of preservation of important fruits and products, processing techniques and equipment. Fruits, vegetables, flowers processing and marketing. Principles and scope of dry-land horticulture. Green house technology.

SECTION - C

1) Diseases and pests of cereals, pulses, oilseeds, fibre, sugarcane, orchard and plantation crops of Maharashtra and their control. 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. Bio-fertilizers, Pesticide residues and their hazards. Storage pests and diseases of cereals and pulses and their control. Plant Quarantine. Mushroom cultivation, Sericulture, Apiculture.

2) Livestock production of Cattle, Goat, Sheep, Poultry, Pig in Maharashtra. Livestock breeds and their characteristics. Breeding, feeding and management of dairy animals. Classification of feeds, fodder, preservation of fodder. Pasture and grassland management. Animal health and livestock development programmes.

SECTION - D

1) Farm management, scope, importance and characteristics of 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. Implications of GATT (WTO) agreement in agricultural marketing. Agricultural Business Management- environment of agricultural business, tasks of professional managers, management system and processes, types of management decisions, decision making techniques and processes, organisational culture and management ethics.

2) Rural problems and characteristics of rural and farming community. Agricultural extension, its importance and role, extension teaching methods, aids and mass media, methods of evaluation of extension programmes, socio-economic survey and status of big, small and marginal farmers and landless agricultural labourers. Training programmes and methods of training for extension workers. Different rural and agricultural development programmes. T & V system, NATP, ATMA programmes and PRA, RRA techniques and role of public and private extension systems. Information technology and its role in agricultural development.

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BOTANY (OPTIONAL)
(CODE NO. 601)

Standard :- Degree
Medium :- English
Nature :- Conventional (Essay) type

Total Marks :- 200
Duration **:-** Three hours

SECTION - A

1) Cell Biology :

Prokaryotic and eukaryotic cell structure, cell wall, cell membrane-membrane transport, functions of cell organelles, mitosis and meiosis, significance of meiosis, numerical and structural variations in chromosomes and their importance.

2) Genetics, Evolution and Plant Breeding :

Mendelism and post-Mendelian concept; concept of gene and genetic code, regulation of gene expression ; linkage, crossing over, marker genes, chromosomal mapping-location of genes. linkage maps ; mutation and polyploidy, hybrid vigour, sex chromosomes, cytoplasmic and sex - linked inheritance, sex determination, structure and synthesis of nucleic acids. organic evolution **:** evidences, mechanism and theories, role of RNA in organic evolution.

Methods of Plant breeding - introduction, selection and hybridization (pedigree, back cross, mass selection, bulk method). male sterility and heterosis ; use of apomixis in plant-breeding. Biostatistics : Standard deviation and coefficient of variation (CV); Tests of significance (t - test and chi-square test), probability and distribution, correlation and regression.

3) Tissues and Tissue Systems :

Origin, development, structure and function of primary and secondary tissues ; structure of wood, epidermal, secretory and mechanical tissue systems ; normal and anomalous secondary growth.

SECTION - B

1) Diversity of Lower Plants (Cryptogams) :

General characters, structure and reproduction from evolutionary view point of Algae and Fungi with the help of suitable taxa. Economic importance of algae and fungi, vegetative structure and reproduction in Bryophytes (Hepaticopsida, Anthocerotopsida and Bryopsida) and Pteridophytes (Psilopsida, Lycopsida, Sphenopsida and Pteropsida), nature of alternation of generations, apospory and apogamy. Lichens **:** classification, structure, methods of reproduction, economic importance and ecological significance**.**

2) Diversity of Seed Plants and their Systematic :

Characteristics of seed plants; evolution of the seed habit; general features of the Gymnosperms and their classification; geological time scale; morphology of vegetative and reproductive parts and life cycles of *Cycas, Pinus and Gnetum*.

Angiosperms : origin and evolution.

Plant systematics : Botanical nomenclature- principles and rules; comparative account of systems of classification of angiosperms (Linnaeus, Bentham and Hooker, Engler and Prantle, Hutchinson and Cronquist); modern approaches in plant taxonomy. Diversity of flowering plants as illustrated by members of the families: Ranunculaceae, Magnoliaceae, Annonaceae, Brassicaceae (Cruciferae), Malvaceae, Sterculiaceae, Tiliaceae, Fabaceae (Papilionaceae), Caesalpinaceae, Mimosaceae, Rutaceae, Anacardiaceae, Meliaceae, Cucurbitaceae, Apiaceae (Umbelliferae), Rubiaceae, Asteraceae (Compositae), Asclepiadaceae, Bignoniaceae, Verbenaceae, Euphorbiaceae, Arecaceae (palmae), Poaceae(Gramineae), Liliaceae, Scitaminae, Orchidaceae.

3) Method of Reproduction and Seed Biology :

Vegetative, asexual and sexual methods of reproduction in seed plants, structure and development of male and female gametophytes, pollination, fertilization, endosperm and embryo development, polyembryony, sexual incompatibility; development, structure, dormancy and germination of seed.

SECTION - C

1) Microbiology and Plant Pathology:

Microbiology: Culturing of organisms (bacteria and fungi) - types and preparation of culture media; sterilization techniques; soil microbes and their role; ultra structure, multiplication, reproduction and economic importance of bacteria and viruses.

Plant Pathology: Important plant diseases caused by viruses, mycoplasma, bacteria, fungi and nematodes; physiology of parasitism, various control measures, disease resistance, defense mechanisms; fungal toxins.

2) Plant Physiology and Biochemistry:

Water relations, mineral nutrition and ion-transport; Photophosphorylation and C3 and C4 pathways of photosynthesis; CAM, photorespiration. Respiration- aerobic and anerobic (including fermentation), electron transport chain and oxydative Phosphorylation; energy transfer and ATP synthesis, Enzymes : Properties and nomenclature, enzyme specificity, effect of pH and temperature on enzymes, enzyme inhibitors, enzyme immobilization; nitrogen fixation, protein synthesis; growth and growth substances- auxins, gibberellins,

cytokinins and abscisic acid; Secondary metabolites and their importance; photoperiodism and flowering, vernalization; senescence; plant movements.

SECTION - D

1) **Environmental Botany and Plant Geography:**

Biotic components, Edaphic components - soil formation, soil profiles, soil texture, soil reaction, ecological adaptations; Plant succession, types of vegetational zones; Ecosystems- concept, types of ecosystems; food chain, food web, ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen and phosphorous; soil erosion - types of erosion and methods of control; afforestation, deforestation, social forestry; envioronmental pollution- types and control; bioindicators, endangered plants, endemism; phytogeographical regions of India; forest types of India.

2) **Plants and Human Welfare:**

Plants as a souce of forest products such as food, fodder, fibres, wood and timber,paper, rubber, beverages, narcotics, spices, resins, dyes, drugs insecticides, pesticides and ornamentals. Engergy plantation, biofertilizers; germplasm resources, importance of conservation; tissue culture in plant propogation and enrichment of genetic diversity; somatic embryogenesis and synthetic seeds; gene cloning, genetic engineering, fermentation; application of palynology; role of biotechnology in agriculture, horticulture, medicine and industry; greenhous technology, post harvest technology; mushroom and medicinal plants cultivation.

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CHEMISTRY (OPTIONAL)
(CODE No. 602)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

1) Atomic Structure :

Quantum theory, Bohr's model, Heisenberg's uncertainty principle, Pauli Exclusion priciple, interpretation of wave function, quantum numbers and their significance, shapes of s,p, and d orbitals.

2) Polymers :

Preparation by condensation and addition polymerisation, properties of polymers, types of polymers.

Preparation and applications of :

Organic polymers: polythene, PVC, polystyrene, teflon, nylon, terylene, synthetic and natural rubber.

Inorganic Polymers - polynitrilic compounds, borazine, silicones, silicates.

Resins - phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde.

3) Spectroscopy :

a) Introduction, electromagnetic radiation, molecular energy levels, degrees of freedom, quantum numbers,

b) rotational motion and spectra of diatomic molecules, selection rules.

c) Vibrational Spectra : Vibrational levels, selection ruels, vibrational spectra of simple hormonically vibrating and unhormonically vibrating molecules, overtones, measurement of vibrational frequency, vibrational spetra of diatomoc molecules, linear triatomic molecules, intensity and position of IR bonds, finger-print region, characteristic absorption of various functional groups, interpretation of spectra of simple organic molecules, determination of force constant and its relation with bond energies. measurement of bond length.

d) Electronic Spectra : Concepts of P.E. Curves for bonding, antibonding M-O. Qualitative description of □,□ and n MO_S, their energy levels and their respective transitions. Effect of conjugation on visible and uv spectra in organic molecules, Woodward-Fieser rules, Calculation of □max, Interpretation of uv spectra.

e) NMR Spectra : Nuclear spin, nuclear energy levels, proton nmr spectra. Equivalent and nonequivalent protons, magnetic anisotropy, coupling constants, interpretation of NMR spectra of simple organic molecules like C_2H_5OH, CH_3 CH_2 Br, toluene etc.(Problems expected)

f) Mass Spectra: Parent peak, base peak, fragmentation of simple organic molecules.

4) Envioronmental Chemistry :

a) Air pollution- air polluntants, potential evaluation mehtod :

Water pollution- sources, domestic sewage, industrial effluents, agricultural discharge, fertilizers, detergents, toxic metals, radioactive materials.

Noise pollution and thermal pollution.

Sewage and sewage treatment.

Acid rain, Greenhouse effect, ozone depletion, London smog.

Solid waste management.

Industrial safety.

b) Chemistry in day to day life:

i) Water - Types, desalination, fresh water, dissolved oxygen and water quality.

ii) Milk - Definition, chemical composition of milk of different species such as cow, buffalo and goat, Adultrants in milk like sugar, H_2O_2, formaldehyde.

iii) Essential Nutrients for Plants - Classification - major and minor, traces, their sources and forms.

iv) Food Adultrants in - Tea leaves, Chilli powder, Turmeric powder.

5) Acid, Bases and Solvents :

i) Arrhenious concept, Bronsted-Lowry concept, Lux-Flood concept, Lewis concept, Solvent system concept.

ii) Conditions for a good solvent, Different solvents used in inorganic and organic reactions, Levelling and differentiating solvents, conjugate acid-base pairs, protic and aprotic solvents.

iii) Strength of acids and bases, Trends in the strength of Hydracids and Oxyacids.

6) Fertilizers and Agrochemicals :

Types of fertilizers, organic and inorganic fertilizers, urea, NPK fertilizers, superphosphate of line, Thomas-Gilchrist slag, Nitre, Phosphates.

Classification of agrochemicals, plant hormones, insecticides and pesticides. Indole acedtic acid Monocrotophos, Cypermethrin, Endosulfan Malathion, Parathion (only structures).

7) The Gaseous State:

Deviation of real gases from the equation of state for an ideal gas, van der Waals and virtual equation of state, critical phenomenon principle of corresponding states, equation for reduced state, specific heat of gases.

8) Thermodynamics :

i) Definitions of thermodynamic terms, Types of systems, Intensive and extensive properties, state and path functions and their differentials, Thermodynamic process, concept of heat and work.

ii) First law of thermodynamics -- statement, definition of internal energy and enthalpy, Heat capacity at constant volume and pressure, Joule's law, Joule - Thomson co-efficient and Inversion temperature, calculations of W, q, □U, □H, for the isothermal and adiabatic expansion of ideal gases for reversible process.

iii) Thermochemistry - Standard state, Standard enthalpy of formation, Hess's Law of heat summation and its applications, Heat of reaction at constant pressure and at constant volume, Enthalpy of neutralisation, Bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchoff's equation.

iv) Second Law of thermodynamics-Need for the law, different statements of the law,Carnot cycle and its efficiency,Carnot theorm. Thermodynamic scale of temperature, concept of entropy, entropy as a state function,entropy as a function of V and T,and of P and T.Entropy change in physical change, Clausius inequality,entropy as a criterion of sponteneity and equilibrium entropy change in ideal gases and mixing of gases.

(Problems on this topic are expected.)

9) Electrochemistry :

i) Electrical transport - conduction in metals and in electrolyte solutions, specific and equivalent conductance, their variation with dilution.

ii) Migration of ions and Kohlrausch law, Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law - its uses and limitations, Debye-Huckel-Onsagar equation for strong electrolytes (elementary treatment only), Transport number, definition and determination by Hittorf method and moving boundary method.

iii) Application of conductivity measurements - determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

iv) Types of reversible electrodes- gas- metal ion, metal- metal ion, metal- insoluble salt - anion and redox electrodes, Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode - reference electrodes, standard electrode potential, sign conventions, electrochemical series and its applications.

v) E M F of a cell and its measurements, computation of cell E M F, calculation of thermodynamic quantities of cell reactions (□G, □H and K), polarization, over potential and hydrogen over voltage.

vi) Concentratin cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility porduct and activity co-efficient, potentiometric titrations.

(Problems on this topic are expected).

10. Chemical Kinetics :

i) Concentration dependence of rate of reaction.

ii) Differential and integral rate equations for zero, first, second and fractional order reactions.

11) Surface Phenomena and catalysis:

i) Adsorption from gases and solutions on solid adsorbents, adsorption isotherms, Freundlich, Langmuir. isotherms, determination of surface area characteristics.

ii) Homogenous and hetrogenous catalysis and their characteristics, mechanism of heterogenous catalysis, enzyme catalysed reactions.

12) Colligative Properties:

Dilute solutions and colligative properties, determination of molecular weights, using colligative properties. melting point, boiling point, osmotic pressure, surface tension, refractive index.

13) Chemical Bonding:

i) Ionic, covalent and co-ordinate bond.

ii) Conditions for formation of ionic, covalent and co-ordinate bond.

iii) Characteristics of ionic compounds.

iv) Factors affecting stability of ionic compounds.

v) Characteristics of covalent compounds.

vi) Lattice energy, Born-Haber Cycle.

vii) Polarity of covalent bond, dipole moment.

viii) Valence Bond Theory- Assumptions

ix) Explanation of bonding in molecules by V.B. Theory.

x) Hybridisation- Need, definition, concept, application.

xi) Types of hybridisation- sp, sp2, sp3, dsp2, dsp3, d2sp3.

xii) Resonance and resonance energy.

xiii) Bond order, bond length and bond energy- relation between them.

14) General Chemistry of transition elements :

i) Transition element.
ii) Electron configuration.
iii) Position in the periodic table.
iv) Their characteristic properties.
v) Trends in the properties like atomic and ionic radii, oxidation states, colour, magnetic properties, complex formation, catalytic property, reactivity.
vi) Non-stoichiometric compounds.

15) General chemistry of f-block elements :

i) The f - block elements.
ii) Their position in the periodic table.
iii) Electron configuration.
iv) Oxidation states of lanthanides and actinides.
v) Lanthanide contraction and its effects.
vi) Colour of lanthanide compounds
vii) Magnetic properties of lanthanides.
viii) Occurrence of lanthanides and actinides.
ix) Methods of isolation of lanthanides-solvent extraction and ion-exchange.
x) Application of lanthanides.
xi) Comparision of lanthanides and actinides.
xii) Methods of preparation of actinides.
xiii) Nuclear fission and fusion.
xiv) Nuclear fuels.

16) Co-ordination Chemistry :

i) Werner's theory of co-ordination compounds and its experimental verification.
ii) IUPAC nomenclature of co-ordination of compounds.
iii) Terms used in co-ordination compounds.
iv) Effective atomic number principle and its application.
v) Theories to explain bonding in co-ordination compounds.
vi) Valence Bond Theory : Assumption, explanation of bonding in compounds with co-ordination number 4 and 6, merits and demerits of the theory.
vii) Crystal Field Theory : Assumption, splitting of d orbitals, explanation of bonding in compounds with co-ordination number 4 and 6, crystal Field Sabilisation Energy and its calculations, merits and demerits of the theory.
viii) Comparision of Valence bond and crystal field theories.

17) Bio-inorganic Chemistry:

i) Essential and trace elements in biological processes.
ii) Metalloporphyrins with special reference to haemoglobin and myogobine.
iii) Biochemical role of alkali an alkaline earth metal ions with special reference to Ca^{2+} ions.
iv) Nitrogen fixation, Nitrogen cycle.
v) Biochemical effect of toxic chemicals containing arsenic, cadmium, lead and mercury.

18) Corrosion:

i) Types of corrosion. **ii)** Theories of corrosion.
iii) Effects of corrosion. **iv)** Methods to prevent corrosion. **v)** Applications.

19) Reactive intermediates:

Electronic effects, generation, geometry, stability and general reactions of carbocations, carbanions, carbenes, benzynes and carbon radicals.

20) Mechanism of reactions:

i) Substitution - SN1, SN2, SNi, aromaticity of benzenoid, non-benzenoid and heterocyclic compounds, electrophitic and nucleophitic aromatic substitution their mechanism and effect of substitutes.
ii) Elimination - E1, E2 mechanisms, Beta elimination, Saytzeff and Hofmann rules.
iii) Addition- Electrophitic addition to C=C and nucleophitic addition to C= O, C = N and C= N.
iv) Rearrangement - inacol-pinacolone, Wagner-Meerwein, hofmann, Beckmann, Fries, Claisen.
v) Name reactions - Aldol condenstation, Claisen Condensation Perkin reaction, Knoevenagel reaction, Wittig reaction, Cannizzaro reaction, Michael reaction, Stobbe condensation, Benzoin condensation, Skraup synthesis, Reformatsky reaction.

21) Fats, Oils and detergents:

Natural fats and oils edible and non-edible oils, Vegetable oils, essential oils, mineral oils, Hydrogenation of oils and fats. Soaps and synthetic detergents, Sodium laury / sulphate.

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CIVIL ENGINEERING (OPTIONAL)
(CODE No. 403)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) Engineering Mechanics :

Concept of force, vector representation**,** collinear force system, concurrent, nonconcurrent and parallel force in a plane, moment, Varignon's theorem, free body diagram, equilibrium conditions, first and second moment of Area, mass moment of Inertia, Principle of virtual work.

Kinematics in Cartesian and polar coordinates, motion under uniform and non-uniform acceleration, motion under gravity.

Kinetics of particles, momentum and Energy principles, D,'Alembert's principle, collision of elastic bodies, rotation of rigid bodies, simple harmonic motion, flywheel.

2) Building Construction And Materials :

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 termites proofing materials, for low cost housing.

CONSTRUCTION : Building components and their functions;

Block masonry : Bonds, jointing. Stone masonry. Design of Brick masonry walls as per I.S. codes, factors of safety, service ability and their strength requirements, plastering, pointing. Types of Floors & Roots, types of buildings, Repairs in buildings.

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

3) Survey and Remote Sensing :

Distance and angle measurement, plane table, levelling traverse contouring, triangulation, corrections and adjustment, survey instruments Tacheometry, circular and transition curves, principles of photogrammetry.

Sources and types of electro-magnetic energy used,, principles and geometry of scanners, characteristic of sensors, fundamentals of satellite image, technique of visual and digital interpretation,principles multispectral data analysis, image processing, rectification,enhancement. Applications for resources, exploration, land use, land cover.

4) Quantity Surveying, Contracts and Tenders :

Estimating, types of estimates, units & modes of measurement, methods of approximate estimate of Civil Engineering project, taking out quantities, analysis of rates, specification of major civil works, methods of valuation.

Contract : types of contract, various conditions, termination of contract.

Tenders : Types of tenders, tender notice, documents, method of preparation & submission of tender, scrutiny & acceptance of tenders.

SECTION - B

1) STRENGTH OF MATERIALS:

Simple stress and strain, elastic constants, axially loaded compression members, principal stresses and strains in biaxial mode, Mohr's circle, sheer force and Bending moment; theory of pure bending, shear stress distribution across cross sections, strain energy in direct stress, bending and shear, deflection of beams using various methods, Torsion of shafts, close coiled delical springs, thin cylinders under internal pressure, elastic stability of columns, Euler's, Rankine's and Secant formulae, theories of elastic failure.

2) STRUCTURAL ANALYSIS :

Castigliano's theorems, unit load method of consistent deformation applied to beams and pin jointed truses, slope deflection, Kancs method and column analogy method applied to indeterminate beams and rigid frames.

Rolling loads : influence line for SF and BM at a section of a beam, criteria for max S F and B M due to system of rolling loads on a beam, I L for simply supported pin jointed trusses.

Arches: Analysis of three hinged and two hinged arches, temperature effects.

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

Plastic analysis : Theory of Plastic bending, Plastic analysis, statistical method, Mechanism method.

3) STEEL STRUCTURES :

Structural steel: grades, properties and types.

Riveted, bolted and welded joints and connections, design of axially loaded tension and compression members, design of simple and built up beams, design of riveted and welded plate girder, Gantry girder, Stanchions with battens and lacing, slab and Gusseted column base.

4) REINFORCED & PRESTRESSED CONCRETE STRUCTURES:-

Reinforced concrete: Limit state design philosophy, Recommendation of IS Codes, Design of one way and two way slabs, doglegged and openwellstaircase, Simple and continuous beams of rectangular, Tee and 'L' sections, Compression members under direct load and bending, isolated and combined footings, cantilever and counterfort retaining wall, Rectangular and circular water tanks resting on ground.

Prestressed concrete: Materials, systems of prestressing, analysis of beams, for flexure load balancing, Loss of Prestress, Recommendation of IS Codes, elastic design of simple beams, end block design.

SECTION - C

1) Fluid Mechanics, Open Channel Flow And Hydraulic Machines:

Fluid Mechanics : Fluid properties, fluid statics including force acting on plane and curved surface.

Kinematics and Dynamics of Fluid Flow: Velocity and acceleration, streamlines, equation of continuity irrrotational and rotational flow, stream and velocity potential functions, Laplace equation, flow nets and methods of drawing flownet, sources and sinks, flow separation, free and forced vortices.

Control volume, continuity, equation momentum, energy and moment of momentum equation from control volume concept, Bernoulli's equation, Navier-Stoke's equation, Euler's equation of motion, application to fluid flow problems, 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, 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 flat plate, laminar sublayer, smooth and rough boundaries, drag and lift.

Turbulent flow through pipes: Characteristics of turbulent flow, velocity distribution and variation of friction factor, hydraulically smooth and rough pipe, head losses, Darcy - Weisbach equation, Moody's diagram. Energy and hydraulic grade line, Syphons, expansion and contraction in pipes, pipe flow. Pipe network, 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 flow and critical depth, resistance equations and variation of roughness coefficient, Chezy's and Manning's equation, rapidly varied flow, flow in contractions and at sudden drop, hydraulic jump and its applications, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation.

Hydraulic Machines: Centrifugal pumps **:** Types, Characteristics, net positive suction Head (NPSH), specific speed, Pumps in parallel and series.

Reciprocating Pump, Air vessels, Hydraulic ram, efficiency parameters, Rotary and positive displacement pumps, diaphragm and jet pumps.

Hydraulic Turbines, types and classification, choice of turbines, performance parameters, control, characteristic, specific speed.

2) ENVIRONMENTAL ENGINEERING

Water Supply : Estimation of surface and subsurface water resources, population forecasting, prediction of water demand and its variation, impurities of water and their significance, Water quality: Physical, Chemical and bacteriological analysis, water borne diseases. River, reservoir, and Canal intakes. Infiltration galleries and wells, Tube wells Pumping and gravity schemes.

Water Treatment : Screening, Aeration, Coagulation flocculation and sedimentation, slow and rapid sand filters, pressure filters chlorination, softening**,** Removal of iron and manganese**.**

Water Storage and Distribution : Storage and distribution reservoirs- Types, location and capacity.

Distribution systems : Layouts, pipe fittings, valves including check and pressure reducing valves, meters, analysis of distribution systems, leak detection, maintenance of distribution systems, Pumping station and their operations.

Wastewater: Sewerage systems: Separate and combined system, estimation of domestic, industrial and storm water flows and their variations, flow through sewers, sewer appurtenance, manholes, inlets, junctions syphons, plumbing in Public buildings.

Wastewater Characteristics: Various characteristics, such BOD, COD, TOD, TOC, DO, Solids, SS, nitrogen. Standards of disposal in aquatic bodies and on land. Self purification of streams. DO sag curve and its significance.

Waste water Treatment: Working principles, screening, grit chambers, sedimentation tanks, trickling filters, activated sludge process, oxidation pond, sludge digester, septic tanks, disposal of sludge, recycling and reuse of wastewater.

Solid Waste: Collection and disposal in rural and urban context, management of long term ill effects.

Air pollution: Sources, types of pollutants, effects on man, animals, vegetation. Standards. Atmospheric stability and pollutant dispersion. Air pollution control, and control acts.

Environmental Pollution : Sustainable development, Environmental Impact Assessment of Thermal Power Plants, mines, and river valley projects.

Ecology : Basic concept of ecology, ecosystem concept, ecological systems (lake, forest, cropland); ecological interactions and balance, Biogeochemical cycle, energy flow, food web, ecological pyramid, ecological indices, ecological succession.

3) IRRIGATION ENGINEERING AND WATERSHED MANAGEMENT

Hydrology: Hydrological cycles, precipitation, analysis of precipitation data, evaporation, transpiration, depression storage, infiltration overland flow, factors affecting run off, hydrograph, flood frequency analysis, flood estimation, flood routing through reservoirs and channels, Muskingam method.

Groundwater flow: Specific yields, storage coefficient, coefficient of permeability, confirmed and unconfirmed aquifers, aquiferts, radial flow into well under confined and unconfined condition, specific capacity of wells tube wells, pumping and recuperation test, safe yield, groundwater potential .

Water Resources: Ground and surface water resources, Single and multipurpose projects storage capacity of reservoirs, reservoirs losses, reservoir sedimentation.

Irrigation: 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, Canal design based on Kennedy and Lacey's theories for erodible soil formation, cost analysis of lined and unlined canals; drainage behind lining, water logging and Drainage **:** causes, control and drainage system design, salinity, soil reclamation.

Lift Irrigation: Components and concept of design of lift irrigation schemes.

WATERSHED MANAGEMENT: Concept of watershed delineation, land use planning, control of erosion by land and crop management practices, erosion control structures in arable and non-arable lands, morphological characteristic of watershed; farm ponds and percolation tanks:- site, construction and design. Rainwater harvesting, drought analysis and its application. Wetlands and their significance.

4) DAMS AND HYDRAULIC STRUCTURES

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

Spillways: Spillway types, crest energy dissipation and stilling basins,

Diversion Head Works: Selection of site, layout. Bligh, Lane and Khosla's theories, Design of weirs on permeable foundation, Sediment excluder**.**

Cross Drainage Works: Necessity, types, selection, basic principles of design, canal falls - types and Principles of design. Distributory head and other regulatory works.

River Training works: Objective of river training and methods of river training. Principles of hydropower development, Type layouts and component works, Surge tanks types and choice, flow duration curve, dependable flow, storage and pondage, Pumped storage plants.

SECTION - D

1) Geotechnical Engineering and Geology -

Types of Soils, phase relationships, consistency limits, classification of soils, clay mineralogy, effective stress and pore water pressure, permeability, seepage, quick sand, compressibility and consolidation, Terzaghi's theory of one dimensional consolidation. Compaction of soil, field control, total stress and effective stress parameters, pore pressure coefficients, shear strength of soil, Mohr Coulomb failure theory, shear tests. Earth pressure, Rankine theory, Coulomb theory, earth pressure on retaining, walls, sheet pile walls and braced excavations. Stability of slopes, conventional methods, stability number, stress distribution in soil, Boussinessq's theory, New mark chart, pressure bulb, contact pressure.

Subsurface exploration, methods of boring sampling, penetration test, pressure meter tests, bearing capacity, Terzaghi and other important theories, Immediate and consolidation settlement, settlement analysis , types of foundations, choice, types, various types of footing, rafts, pile foundation, types, capacity, static dynamic methods, pile groups, settlement of piles, pile load test, lateral capacity, ground improvement techniques, preloading, sand drains, stone columns, grouting, soil stabilization, geosynthetics.

Petrolosy, Indian Geology, preliminary investigations.

2) Transportation Engineering (Roads, Traffic Engineering, Bridges) - Principles of planning, alignment, geometric parameters, cross sections, camber, super elevation horizontal and vertical curves, classification of

road, low cost roads; flexible pavements, rigid pavements, construction, drainage of roads, surface and subsurface drainage, highway financing.

Traffic Engineering - Forecasting techniques, origin and destination, survey, highway capacity, channeled, non-channeled intersection, rotary desk, elements, marking sign, signals, site lightning, Traffic surveys.

Classification of bridges, preliminary data to be collected during investigations of sites, span, afflux, HFL, scour depth, clearance, location, factors affecting choice, components of bridges, abutment, Pier, wing wall, superstructure, types of bridges, culvet, movable, fixed, bearings.

3) Project Management and Elements of Economics :

Construction activity, schedules, job layout, bar chart organisation of construction firms, project control, and supervisions, cost reduction techniques, network analysis, CPM, PERT, crashing of activities for cost optimisation, updating, resources 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 investements, project profitabilty.

4) Construction Technique and Equipment :

Use of precast elements of various types, use of insitu construction in foundations, production technique, quality control, precautions at joints, considerations such as strength, economy in light weight concrete.

Under water constructions, dewatering techniques, under-water concreting, diaphragm wall; slip form, guniting, shortcrete methods, gabion walls.

Standard and special type of equipments, preventive maintenance repairs, factors affecting selection economic life, time and motion study, capital and maintenance cost, output earth work equipments such as shovel, hoe, bulldozer, dumper, tractor, rollers, group behaviour involving labour and different equipment associated within a chain.

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GEOLOGY (OPTIONAL)
(CODE No. 603)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) **General Geology (Earth Processes and Dynamics) :** Geology and its perspectives. Earth and the Solar System. Origin, Age and Interior of Earth. Weathering and erosion Physiographic subdivisions of India. Occurrence and genesis of different soil types of Maharashtra. Determining soil thickness by Resistivity survey. Earthquakes and Volcanoes. Concepts of Continental Drift, Plate Tectonics, Sea floor Spreading, Mid-ocean ridges, Island Arcs and Trenches. Seismic zones of India with special reference to Maharashtra.
2) **Geomorphology and Remote Sensing :** Geomorphic processes and landforms. Morphometric analysis. Geomorphological mapping based on landforms**.** Mountains ranges, coasts and River systems of Maharashtra. Identification of suitable sites for plantation. Terrain evaluation. Use of Aerial Photographs, Thematic Maps and Satellite Imagery. Principles and applications of Geographic Information System (GIS) and Image processing.

3) Field Geology : Use of Clinometer compass and Brunton compass. Basic concepts of geological map reading. Interpretation of Survey of India toposheets, geological maps and sections. Reading and plotting of field data. Borewell logging. Identification of suitable sites for water reservoirs.

SECTION - B

1) **Mineralogy :** Mineral identification and classification. Physical properties and chemical composition of rock forming minerals. Silicate structures. Petrological Microscope:s its parts and functioning. Optical properties of common silicate minerals. Elementary idea about crystals. Precious and semiprecious stones.
2) **Petrology :** Identification of common rocks of the earth's crust like granite, basalt, andesite, dolerite, grabbro, diorite, granodiorite, granite gneiss, migmatite, granulite, amphibolite, shale, sandstone, limestone, laterite, phyllite, schist, marble. Distinguishing characters like texture, structure and mineral constituents of igneous, sedimentary and metamorphic rocks. Field occurrence, microscopic identification and classification of rock types. Chemical composition of common rock types of the crust. Igneous, metamorphic and sedimentary processes. Geological and petrological features of Deccan Traps.
3) **Structural Geology :** Deformation characters of rocks. Structures in volcanic rocks. Identification of sills and dykes. Types of folds, faults, unconformities, joint planes, fracture planes, cleavages. Schistosity and foliation trends in Precambrain formations of Maharashtra.

SECTION - C

1) **Stratigraphic Principles and Geology of Maharashtra:** Geological Time Scale. Lithostratigraphic, Chronostratigraphic and biostratigraphic methods. Stratigraphic correlation. Geological characteristics of stratigraphic formations (Precambrian, Gondwana, Lameta, Intertrappean, Deccan Traps and Quaternary) of Maharashtra.
2) **Paleontology :** Fossilization process and use of fossils in paleoecology, paleogeography and stratigraphy**.** Methods of fossil collection. Introductory morphological features of common invertebrate, vertebrate and plant fossils. Index fossils and their use. Fauna and flora of Gondwana, Infratrappean and Intertrappean formations of Maharashtra. Identification and use of Microfossils
3) **Economic Geology and Mineral Exploration:** Common ore forming minerals and their distinguishing **properties**. Classification of mineral deposits. Processes of mineralisation. Gemstones and building stones. Geographical distribution of mineral deposits in India with special reference to Iron, Manganese, Petroleum and coal deposits of Maharashtra**.** Introduction to prospecting and exploration methods. Geobotanical and geochemical methods of exploration. National mineral policy. Laws governing surface and underground mining in Maharashtra.

SECTION - D

1) **Hydrogeology:** Hydrologic cycle. Porosity, permeability, storativity and safe yields of various formations of Maharashtra. Types of aquifers in different geological formations of Maharashtra. Preparation of hydrogeological maps. Methods of artificial recharge and rainwater harvesting. Concept of Watershed management and methods of water conservation.
2) **Environmental Geology:** Environmental geology and impact of natural hazards like Earthquakes, Landslides, droughts, Floods and Volcanic erruption. Coastal Erosion and Desertification and their impact on environment. Water Pollution and its effect on natural ecosystem. Remedial measures to reduce water pollution. Hot springs and their geological significance. Environmental problems related to quarrying and mining. Wetland conservation and environmental considerations of waste disposal.
3) **Engineering Geology:** Role of engineering geology in civil construction and mining industry. Engineering properties of rocks. Geological consideration for building safe roads, highways, express ways, dams, bridges and tunnels. Maintenance and precautionary measures to mitigate landslides along the Konkan railway.

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AGRICULTURAL ENGINEERING (OPTIONAL)
(CODE No. 102)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A
FARM MACHINERY AND POWER

1. **Farm Mechanisation :** Status and Scope of farm mechanisation, principles of operations, selection of machinery used for crop production, primary and secondary tillage equipment, sowing and planting equipment, crop harvesting machinery, special farm machinery for Sugarcane, Cotton, Potato and horticultural crops, safety in farm machinery.
2. **Farm Power :** Different sources of power available on farm, Internal Combustion Engines, Two stroke, Four stroke Cycles, Indicated horse power, brake horse power, mechanical and thermal efficiencies.
3. **Farm Tractors :** Tractor engine components**,** Operating Principles and functions of engine systems, Valve mechanism, fuel and air supply, cooling, lubrication, ignition, starting electrical system, governing, transmission system of wheel and tract type tractors**,** clutch and brake, gear box, differential**,** P T O**,** belt and pulley and draw bar, Three point linkage and final drive mechanism, power tillers and small engines for farm operations.
4. **Agro-energy :** Conventional and non-conventional energy sources, fuel options, energy from solar, wind and bio-gas, Solar gadgets: solar cooker, water heater, drier, Photo voltaic systems, Bio-gas plants, their components, utility of bio-gas, selection of bio-gas plants, Wind energy-potential, measurements, wind will, Bio-energy production, conversion, utilisation, energy crops, bio-fuels, classification, Agricultural and forest residue waste as a fuel, Gas technology, its use for thermal and IC engines, food-fuel composition, stove, heat transfer, health aspects, improved stoves.

SECTION - B
SOIL AND WATER CONSERVATION ENGINEERING

1. **Soil Erosion Process and Hydrology :** Soil erosion process, types of erosion, erosion by water and wind, factors affecting soil erosion, estimation of soil loss by USLE, Hydrologic cycles, its components, Runoff: factors affecting runoff, Rainfall-runoff relationship, Estimation of peak rate and runoff volume, hydrographs, Components and analysis of hydrographs, Unit hydrographs, their use.
2. **Soil Conservation measures :** Continuous contour trenches, staggered trenches, bench terraces, diversion drain, contour bund, graded bund, gully control structures, Design and construction details of soil conservation measures.
3. **Water Conservation Structures :** Earthen embankments (i.e. nala bund), small stone masonry dams (i.e. Check dams, K.T. Weirs), farms ponds, their important features and design, Spillways: drop spillway, drop inlet spillway, chute spillway.
4. **Watershed Development :** Watershed development and management concept, types of watershed, delineation of watersheds, morphological characteristics, land capability classification, land use and planning, Evaluation of Watershed Development, Remote sensing: basic characteristic of Photographic images, interpretation keys, Satellite images: fundamentals of satellite images.

SECTION - C
IRRIGATION AND DRAINAGE ENGINEERING

1. **Crop Water Requirements:** Water resources development and utilisation, importance of irrigation, soil-plant-water relationship, Measurement of soil moisture and irrigation water, Water requirement, land development for irrigation, Water Conveyance and control structures.
2. **Application Methods:** Irrigation efficiencies, design of field channels, Irrigation scheduling. Irrigation application methods **:** border, furrow, check basins, sprinkle and drip. Their design and use, Computer application in irrigation scheduling and irrigation application methods.
3. **Ground Water Resources:** Ground water resources , Aquifers, aquifer types, aquifer properties, groundwater movement, Darcy's law, ground water recharge, ground water exploration techniques, steady and unsteady flow to wells in confined and unconfined aquifers.
4. **Farm Drainage:** Drainage problems of agricultural lands, need and benefits, causes and effects of waterlogging, waterlogging prevention, control, Effect of irrigation on drainage. Drainage requirements of various crops, drainage investigation including drainage properties of soil, drainage equations and their use in design. Layout of drainage systems. Types of drainage systems, Surface, subsurface and vertical drainage. Drainage material, and structures. Salt affected soils and their reclamation. Leaching requirements, Drainage installation procedures, recycling of drainage water for irrigation.

SECTION - D
AGRICULTURAL PROCESS ENGINEERING AND FARM STRUCTURES

1. **Processing of grain Crops:** Physio-chemical properties of grains, Rheological properties, and aerodynamics properties, size reduction and size distribution of comminute particles, energy requirement in size reduction, Principles of equipment for milling, mixing, cleaning, grading, drying, and storage, effects of different factors on drying , material handling equipment, storage and storage structures.
2. **Processing of Fruits and Vegetables:** Composition and properties of fruits and vegetables, classification of fruits and vegetables, Mechanical properties, Rheological Properties, stress and strain behavior, Poission's ratio Principles and techniques in preservation of fruits and vegetables. Pre-cooling, cold storage, freezing, dehydration, control and modified atmosphere for storage, process parameters for storing, washing, mixing, handling, cutting, blanching, slicing, canning, bottling, and flexible packaging operations.
3. **Processing of Dairy and Food Products :** Unit operation of various dairy and food processing systems. Process flow chart for a product manufacturers, pasteurization sterilization, homogenization, evaporation, drying, freezing, juice extraction, filtration, and thermal processing.
4. **Farm Structures:** Site selection, design and construction of farmstead, farm house, cattle sheds, dairy barns, poultry sheds; machinery and implement sheds, Design and construction of fence and farm roads, structures for plant environment, green houses, polyhouses, shaded nets, fan pad systems, common building materials used in construction and their properties.

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CHEMICAL ENGINEERING (OPTIONAL)
(CODE No. 408)

STANDARD : Degree **TOTAL MARKS :** 200
MEDIUM : English **DURATION :** Three hours
NATURE : Conventional (Essay) type

Section - A

1) Fluid - Mechanics

Properties of fluid, normal forces in fluids, kinematics of flow, description of velocity fluids, streamline, irrotational flow, potential flow,- Continuity equation for compressible and incompressible flow. - Bernoulli's equation, friction and head loss for pipe flow, friction loss for expansion, contraction and fittings, power requirements for flow ; Layout and calculation of economic pipe diameter. Flow measuring devices for incompressible and compressible fluids fluid, fluid-machineries. Boundary Layer theory, velocity profile.Flow through packed bed and fluidized-bed Mixing and Agitation.

2) Transport Phenomena

Transport properties and mechanisms, Rheolgy of non-Newtonian fluids, Flow through circular pipes, Overall Mass, Momentum and energy balances, Mass balance with chemical reaction. Navier Stoke's equation, Application of Navier's stoke's equation Flow around submerged solids. Turbulent flow mechanism Analogies of transfer processes. Mass transfer in binary system with or without chemical reaction.

3) (a) Mechanical Operations

Size reduction, stages of reduction, laws of energy. Screening, Screen Analysis, particle-size distribution. Storage and handling of Solids. Transportation of solids Gravity setting, Sedimentation, Floculation. Filtration, types of filtration, filter-calculation, Filteration equation for Compressible and non-compressible cakes. Centrifuges - Types of adsorption and its application

(b) Process Calculations

Material and energy balance calculations in processes with recycle / by pass / purge. Heating value of fuels, calculations involving theoretical and excess air, Heat and material balances of combustion processes for solids, liquid and gaseous fuels.

Section - B

1) Mass - Transfer

Deffusion -Molecular diffusion in gases and Liquids. Application of molecular diffusion. Mass- transfer coefficients. Eddy diffusion, Penetration and Film theories of Mass-transfer. Inerphase mass-transfer. Vapour - liquid Equilibria for ideal and non - ideal systems. Distillation, Simple distillation, Fractionation, plate, packed column for distillation.

Gas absorption - Equilibrium relationship.

Humidification -Psychometric chart and its applications. Fundamental concept in humidification and dehumidification.

Liquid-liquid Extraction - Study of different co-ordinate systems, classification of equipments.

Adsorption and ion-exchange - Equilibrium calculation,

Leaching - Principles, equipements and calculations.

Crystallization - Principles and calculation of yield.

Drying - Constant rate period and falling rate period concept**.** Different - types equipements used for drying.

2) Chemical Reaction Engineering

Review of chemical reaction equilibria, Homogeneous system, collection and interpretation of Kinetic data.

Ideal Reactor - Batch reactor design, plug flow reactor design and CSTR design.

Thermal characteristics of Reactor, Principle of optimization, optimum-temperature progression.

Residence time distribution, application to ideal reactors, prediction of reactor performance.

Kinetics of fluid - solid catalytic reaction. External transport process. Reactor and diffusion within porous catalyst.

Non- catalyst gas - solid reaction. Analysis of rate data for non-catalyst fluids-solid systems.

3) Chemical Engineering Thermodynamics :

First Law of Thermodynamics; reversible and irreversible processes and entropy, The second law of Thermodynamics; Application of first and second laws to steady and unsteady processes. Enthalpy and auxiliary functions; PVT relationships for pure components and mixtures, energy functions and interrelationships, fugacity, activity and chemical potential, vapour-liquid equilibria for ideal and non-ideal, single and multicomponent systems, criteria for chemical reactor equilibrium, equilibrium constant and equilibrium conversions power and refrigeration cycles.

Section - C

1) Instrumentation and control

Measuring instrument for process variables like level, pressure, flow, temperature, PH and concentration with indication in visual/ penumatic/analog and digital signal forms. Control variable, manipulative variable and

load variables, control value types, Lenean control theory- Laplace transforms, PID controls, Relay control, Block diagram representation-transient and frequency response, stability of closed loop system- computer based process control systems.

2) Chemical Engineering Economics :

Fixed, variable and working capital costs for a process industry and different methods of cost estimation. Alternative investment, comparisons and replacement costs. Net present worth by discounted cash flow. Depreciation, taxes, insuances, ROR and payout period, Break-even point analysis. Project scheduling-PERT and CPM. Plant location and plant layout including piping.

3) Materials Technology :

Engineering properties and methods of fabrication of materials like timber, plastics, rubber, metals and alloys. Factors determining the choice of materials of construction in Chemical-Industries. Corrosion of metals, Uniform and Localisid corrosion and methods of prevention. Importance of alloy steels including stainless steels, aluminium and titanium as suitable materials of construction.

Section - D

1) Heat Transfer :

Modes of heat-transfer, Fourier's Law, heat-transfer through plane, cylindrical and spherical walls. Heat transfer by convection, film concept, individual and overall heat transfer-coefficients. Heat transfer by parallel and counter flow, concept of log mean temperature difference. Heat transfer by film-wise and dropwise condensation in horizontal and vertical tube boiling Heat exchange equipments - double pipe, parallel, counter-current, shell and tube. Concept of NTU in heat exchangers.

Evaporators : Classification and its application. Heat transfer through submerged coils, jacketted vessels Concept of Black-body radiation, emissivity and absorbivity.

2) Chemical Engineering Processes

Natural organic products, wood and wood based chemicals, sugar, pulp and paper, agro-chemicals, edible oil extraction (including tree based seeds), Biomass gassification including biogas, Petroleum and natural gas-petroleum refining (including atmospheric distillation / cracking / reforming). Industrial processes for the production of sulphuric, nitric and phosphoric acid, ammonia, caustic soda and chlorine. Fermentation process for alchols. Principles of unit processes such as oxidation, sulphonation, nitration, chlorination and polymerisation.

3) Environmental Engineering and safety

Ecology and environment. Pollutants in air and water and their permissible limits, ozone layer depletion, acid rain, solid wastes- biodegradables and non-biodegradable and their recycling and disposal techniques, fire and explosion hazards rating HAZOP and HAZAN. Emergency, planning and disaster management. Environmental legislations, Forest (conservation) Act., Emergency shutdown systems , human element in the design of safety.

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MATHEMATICS (OPTIONAL)
(CODE No. 604)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) Algebra : Group, Subgroup, Normal subgroup, Permutation group, Cayley's theorem, Quotient group, Homomorphism, Isomorphism, Theorems of isomorphism.
Rings, Ideals, Euclidean domains, Principal ideal domains, Unique factorisation domains.

2) Linear Algebra :
Vector space, Subspace, Linear dependence and independence, Bases, Finite dimensional vector spaces.
Linear transformation and their representation as matrices. Eigen values and Eigen vectors, Cayley Hamilton theorem, Row and Column reduction, Echelon form, Rank.

3) Linear Programming : Theory and application of the simplex method of solution of a linear programming problem.

SECTION - B

1) Differential Calculus :
L.u.b. property of real numbers, Limits, Continuity and uniform continuity of functions, Properties of continuous functions, Continuous functions on compact sets.
Differentiability, Rolle's theorem, Mean value theorem, Taylor's theorem with remainder, Indeterminate forms, Maxima and minima.
Functions of several variables, Continuity, Differentiability, Partial derivatives, Maxima and minima, Lagrange's method of multipliers, Jacobian.

2) Integral Calculus :
Riemann Integral, Definite integral, Indefinite integral, Infinite and improper integrals, Double and triple integrals (evaluation techniques only) . Area under a curve, Surface area, Volume.

3) Sequences and Series :
Cauchy sequences, Completeness, Absolute and conditional convergence of series of real and complex terms, Rearrangement of series, Uniform convergence of sequences and series of functions, Continuity, differentiability and integrability for sequences and series of functions.

SECTION - C

1) Analytic Geometry :
Cartesian and polar coordinates in two and three dimensions, Second degree equations in two and three dimensions, Reduction to canonical forms, Straight lines, shortest distance between two skew lines, Plane, Sphere, Cone, Cylinder.

2) Vector Analysis :
Scalar and vector fields, Triple products, Differentiation of a vector function of a scalar variable, Gradient, Divergence and curl in Cartesian, cylindrical and spherical coordinates and their physical interpretations.
Vector integration. Theorems of Gauss, Green, Stokes and problems based on these.

3) Dynamics :
Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion, Motion on smooth and rough plane curves.
Motion in a resisting medium, Motion of particles of varying mass.
Central orbits. Kepler's laws of motion.

SECTION - D

1) Ordinary Differential Equations :
Equations of first order and first degree, Integrating factor, Equations of first order and higher degree, Clairaut'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.

2) Numerical Analysis :
Numerical Methods : Solution of algebraic and transcendental equations of one variable by bisection, Regula - Falsi method and Newton - Raphson method, Solution of system of linear equations by Gauss 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, Trapezoidal rule, Gaussian quadrature formula, Numerical solution of ordinary differential equations, Euler and Runge-Kutta methods.

3) Computer Programming :
Bits, Bytes, Numbers in binary and other bases, Algorithms, Flow charts, Simple programs in C / recent computer language.

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MECHANICAL ENGINEERING (OPTIONAL)
(CODE No. 406)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION -A

1) Strength of Materials :

Different engineering metallic materials as cast iron, wrought iron, Steel and different types of alloys. Required properties of these materials and their practical applications.

Introduction to nonmetallic materials like timber, cement, refractory, plastics, rubber, ceramics and insulating materials.

Tensile, compressive and shear stresses. Stress-strain diagram. Principal plane and Principal stresses and strains. Mohr's circle and Poissons ratio. Bending stresses, combined bending and direct stresses.

Classification of beams as simply supported, fixed ends, overhanging and cantilever types. Different types of loading the beams. Shear force and bending moment diagrams. Importance of these diagrams for the design of beams.

2) Theory of Machines :

Different types of mechanisms and their analysis, Different types of cams and their applications. Different types of gears and gears trains.

Balancing of single and multicylinder engines. Vibration analysis of single and two degree of freedom systems**.** Critical speeds and whirling of shafts. Different types of bearing. Belt, chain and gear drives. Brakes and dynamometers. Governing and different types of governers. Introduction to servo mechanisms.

3) Machine Design :

Major design criteria based on tension, compression, shear, bending or combined actions.

Factors of safety and its selection. Fatigue loading and fatigue failure.

Design of main engine parts as piston, connecting rod, fly wheel, crank shaft, bearings. Design of cotter joint and Knuckle joint. Design of keys and couplings, Design of different types of springs as helical spring and leaf spring.

4) CAD / CAM :

Computer graphics, Geometric modeling, Finite element analysis. Introduction to CAM for manufacturing processes.

SECTION - B

1) Manufacturing Science:

Introduction to conventional lathe, shaping machine, drilling machine, grinding machine and milling machine. Different parts of each machine and their function. Cutting tools used with lathe, shaping machines and special milling cutters. Different manufacturing processes carried out on the machines mentioned above. Introduction to indexing and gear cutting.

Moulds and moulding materials. Moulding processes, cores and core prints. Casting, different types of casting methods as die casting and centrifugal casting. Casting defects and methods to avoid them. Forging, forging methods as cold forging and hot forging. Advantages and limitations of forging production.

Welding and classification of welding. Arc and gas welding and spot welding machines. welding applications. welding rods. welding defects and methods to avoid them.

2) Manufacturing Management :

Production planning and control. Operation Scheduling. Assembly line balancing**-** Product development, break even analysis. PERT and CPM methods. Work study, method study.

Inventory control. ABC analysis. EOQ model. Material requirement planning, job design and job standards. Quality management and control. **Operation research :** Linear programming, Graphical and simplex method. Sigma server queuing model. Value engineering, value analysis. Total quality management and forecasting techniques.

Computer organisation and flow charting.

3) Advanced machining methods, CNC Machines and Metrology :

Electric discharge machining. Electro-chemical machining. Ultrosonic machining. Laser beam machining. Plasma arc machining. Introduction NC and CNC machines.

Jigs and fixtures, tools and gauges, different inspection methods.

SECTION - C

1) Fluid forces and Buoyancy :

Properties of fluids and their units (viscosity and surface tension) Hydrostatic forces on submerged planes. Forces acting on dams and gates.

Buoyant forces and center of buoyancy. Required law for a floating body. Meta-centric height and stability of floating body.

2) Law of flowing fluids :

Continuity, momentum and energy equations. Bernaullies equation of motion and its application for work developing (water turbines) and work absorbing systems (pumps). Its use for flow measurement like venturimerter and orifice meters.

3) Dimensional analysis and model testing :

Fundamental dimensions used in fluid mechanics**.** Buckingham pai **(** **)** theorem and its use for model analysis**.** Applications and limitations of dimensional analysis for model testing.

4) Water Power Engineering :

General layout of the hydropower plant. Considerations for the location of the plants. Storage type and Run off river plants. Pump storage plants.

Different parts of hydropower plant like dams, spillways, penstoks. surge tanks and prime movers. Selection of prime movers.

Specific speed and its importance in the selection of prime movers. Advantages and disadvantages of hydropower plants. Speed regulation of prime movers.

SECTION - D

1) Applied Thermodynamics :

1st and 2nd law of Thermodynamics. Application of 1st law of thermodynamic for work developing and work absorbing systems. Universal gas equation and its application. Boiler classification, fire tube and water tube boilers, basic mounting and accessories, performance of boilers. Introduction to thermal power plants with all basic components and cycles.

2) I.C. Engines :

Petrol and Diesel engines. 2 stroke / 4 stroke engines. cycles of operation. Different parts of IC engine. Ignition, fuel injection, cooling and lubrication systems of engines.

Fuels used in IC engine and their rating. Applications of IC engines and performance testing. Introduction to supercharging, its advantages and limitations.

Emission, pollution and its control.

3) Air Compressor :

Single stage reciprocating compressor and calculation of power requirement. Multistaging of compressor and method to improve its performance. Inter coolers and after coolers. Introduction to rotary compressor.

4) Refrigeration, Air conditioning and Heat Transfer :

Refrigeration - Principle and operation of vapour compression and vapour absorption refrigeration system. Refrigeration cycles. Performance of refrigeration systems, Different refrigerants and their properties and selection. Domestic refrigerators.

Air conditioning - Psychometric properties and charts. Comfort index. Cooling load calculations. Comfort and industrial air-conditioning systems.

Different types of window air conditioners. Air coolers and air cooled systems.

Heat Transfer - Basic modes of heat transfer. Concept of overall heat transfer coefficient. Combined modes of heat transfer. Different laws of radiation. Different types of heat exchangers - parallel flow, counter flow and cross flow. Concept of LMTD.

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PHYSICS (OPTIONAL)
(CODE No. 606)

STANDARD: Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) Mechanics, Properties of Matter, and Waves and Oscilations Mechanics :

Vectors and Scalars **-** Physical quantities as Vectors and Scalars, Dot and Cross product, Vector triple products, Vector addition and subtraction. Flux of a vector field, Gradient of a scalar, Divergence and Curl of a vector, Gauss theorem, Stokes theorem (without proof) and its applications.

Particle Dynamics **-** Inertial frame, Newton's laws of motion, Simple applications of Newton's laws such as - **i)** Projectile motion **ii)** motion in a resistive medium, linear and angular momentum, Torque equation, Kinetic and potential energy, Conservative Potential, Principle of conservation of momentum, principle of conservation of angular momentum, Principle of conservation of energy.

Elastic and inelastic collisions, Rotating frame of reference, fictitious forces. Uniform circular motion, centripetal and centrifugal force, Coriolis force, Motion with a variable mass - One stage Rocket motion.

Law of gravitation, Gravitational potential due to a spherical shell and due to solid sphere, Kepler's laws of planetory motion. Weightlessness in rocket motion.

Rigid Dynamics - Rotational motion of a rigid body about an axis, Moment of inertia, Product of inertia, Moment of inertia of simple objects like, rod, disc, sphere, Theorem of parallel and perpendicular axis, Kinetic energy of a rigid body, Angular momentum of a rigid body, Simple rigid body motion such as Rolling of a disc down the inclined plane, motion of flywheel, Keter pendulum, Gyroscope and gyroscopic motion and its applications.

Properties of Matter : Viscosity - Newton's law of Viscosity, Coefficient of viscosity lamiler flow of a fluid, and applications, Poisullie flow and determination of coefficient of viscosity (□) by Poisullie's method, Determination of (□) by a rotating disc method, Bernoullies theorem of a fluid flow and its application.

Surface Tension - Idea of a surface tension, surface energy, Liquid in contact with solid, pressure on a curved membrane of uniform tension, Measurement of a surface tension, Capillary method of finding Surface Tension.

Elasticity - Stress, Strain, Hooks Law, elastic, Limit**.** Module of elasticity and relations between them, Measurement of Young's modules, Bending moment, Cantilever, Loading of a beam at the center when it is supported at the two ends.

Special theory of Relativity - Michaelson and Morley's experiment, Lorentz transformation, Length contraction and Time dilation, Proper time, Addition of velocity, mass-energy relation, Application to decay processes. Four vector- Light cone.

Waves and Oscillations : Simple Harmonic Motion and their compositions, Damped harmonic motion, Forced oscillation, Resonance, Beats, Stationary waves, Phase and group velocity,

Transverse oscillations of a stretched string, Longitudinal waves.

2. HEAT AND THERMODYNAMICS:

THERMODYNAMICS: Zeroeth, first and second law of thermodynamics, Adiabatic, isothermal and isobaric processes.

Reversible and irreversible processes, Carnot engine, Thermodynamic definition of entropy, Absolute scale of temperature, Thermodynamic potentials (Internal energy, enthalpy, free energy and Gibb's free energy), Otto cycle, Rankin cycle, Diesel cycle.

Gibb's phase rule, Clausious - Clapeyron equations, Joule- Kelvin effect, liquifaction of gases.

Kinetic theory of gases - Ideal gas equation, Maxwell - Boltzman distribution (qualitative ideas), equipartition theorem.

Real gases, Van der Waals equation of state.

HEAT : International practical temperature scale, Thermometry (Gas thermometer, platinum wire thermometer), Qualitative ideas of adiabatic demagnetization.

Thermal conduction of heat, Thermoelectric effects - Thermocouple.

SECTION - B

3) OPTICS

Geometrical Optics : Fermat Principle, Law of reflection - Refraction on the basis of Fermat Principle, Huygens Principle - application to reflection and refraction, Cardinal and nodal points - thin lens approximation, Image formation by thin lenses and their combination, Achromatic lens combinations, Spherical and chromatic abreviations, Spherical mirrors

Total internal reflection - Light Guide, optical fiber.

Optical Instruments - Camera, Projector, Compound microscopes, Astronomical and terrestrial telescopes binoculars, Entrance and Exit pupil, Field of view, Resolution, Magnification, Eye pieces - Gaussian eye piece, Ramsden eyepiece and Kellner's eye piece.

Physical Optics :

Interference of Light - Principle of Superposition - Coherent sources and conditions of interference, Young's experiment, Fresnel Bi-prism, Division of amplitude - Multiple reflection, Amplitude of successive wave in Multiple reflection, Fringes of equal thicknesses and fringes of equal inclination, interference by thin film - Newton's Rings. Hadinger Fringes, Michelson Interferometer, Fabry-Perrot interferometer. Holography and its applications. Diffraction of Light - Fraunhofer Diffraction - Single slit, Double slit, Circular Aperture - Diffraction grating. Fresnel Diffraction - Half period zones and zone plates. Resolving power, Rayleigh criterion, Resolving power of grating, Microscope and Telescope.Polarization of Light - Production and Detection of plane polarized light, Polaroids and Nichol Prism, Polarization by reflection - Brawster's law, Circularly and Elliptically Polarized light, Quarter wave and half wave plates. Optical activity and its origin. Double refraction - Huygens theory. Characteristics, Principle, Construction, working and applications of He-Ne and Ruby lasers.

4) Electricity and Magnetism :

Electricity- Electrostatics - Coulomb's law due to a point charge, Principle of superposition, Force on a charge due to system of charges, Electric field and potential in simple cases. Gauss law and its applications in a highly symmetric situations. Conductor and insulator, Electric field to be zero inside the conductor, Laws of induction, Electric field due to dipole, Method of images, Potential due to a point charge infront of a grounded conducting plane, A potential due to a point charge infront of a grounded metallic sphere. Macroscopic fields, Polarization density, electrical susceptibility, Electric displacement, Dielectric constant, Capacitor, Capacitance of a parallel plate capacitor with and without dielectric slab in it, Capacitor arrangement in series and parallel.

Current Electricity - Steady current sources (Batteries), Biot - Savart law. Calculation of magnetic induction due to a circular coil along its axis concept of magnetic moment due to circular coil, Ampere circuital theorem. D.C. circuits, Kirchhoff's laws, D.C. and A.C. Bridges.

Magnetism - Dia, para and ferro magnetism, Curie's law of susceptibility, Magnetization Hysteresis curve magnetic field due to solenoid, Determination of hysteresis curve of a ferromagnetic sample.

Electromagnetism - Energy density stored in electric and magnetic field, Faradays law of induction, Lenz law, electric generator and electric motor, Principle of transformer and L C R circuits, Frequency filters, Series and parallel resonance, Maxwell's displacement current, Maxwell equations, Derivation of wave equation of **E** and **B** without sources, Electromagnetic spectrum, Principle and working of simple instruments like electric tube, Xerox machine, etc.

SECTION - C

5) SOUND -

Principle of superposition of sound waves, Beats, Velocity of Sound and its measurement Laplace correction, Intensity of sound, Decibel unit, Audibility scale, Musical scale, Reverberation, Sabine's formula (no derivation) Vibration of string, harmonics. Doppler effect. Production and uses of Ultra sonic waves, Sonar.

6) Modern Physics :

Atomic physics - Rutherford's model of atom, its drawbacks, Bohr model of atom, Explanation of spectral series like Balmar, Lyman and Paschan series, Rydberg constant Formula for spectroscopic term series of Balmer, Lyman amd Paschan. Pauli exclusion principle, Four quantum numbers vector atom model L- S coupling, Spectrum of one electron atom like Na, Zeeman effect X-ray spectra, Moseley's law, Periodic table.

Nuclear Physics - Atomic nucleus, discovery of neutron, Static properties of nucleus - mass, radius, Binding energy, Isotopes. Binding energy curve. Fission and fusion, Nuclear reactor, Production of electricity from fission reactor. Discovery of X-rays, Properties of X-rays, X-rays Spectrum, Radioactivity - □, □ and □-ray emission, Half life, Decay rates, Law of radioactive decay, Carbon dating, Geiger-Muller counter.

Quantum Theory - Black body radiation **-** Rayleigh Jeans law, Wein's law, Wein's displacement law, Planck's radiation curve, Concept of photon. Photon energy and momentum, Photoelectric effect, Determination of Planck's constant using photo electric effect, Photo multiplier tube, Compton effect. Wave particle duality, Matter waves, De Broglies relation between the wavelength of a matter, wave associated with particle and its momentum, Electron diffraction, Davison-Germer experiment, Wave equation of the matter wave (Schrodinger time dependent equation).

SECTION -D

7) Solid State Physics:

Crystal Structures - Types of symmetry, Wigner Seitz cell, Bravious Latices - Cubic systems - C_sCl, diamond, and hehaxgonal structures (Symmetry of the system, atoms / unit cell, Co-ordination number, nearest neighbor distance in term of lattice parameter, Interplaner distance), Miller indices, X-ray, Wavelength energy relation, Braggs law, Reciprocal lattice, Determination of crystal structure using Debye - Scherrer - method, (Powder method), Extinction rule, Neutron diffraction (Qualitative).

Ionic, covalent and metallic bonding.

Free electron theory of metals :- E-k diagram, Fermi distribution, Density of states, Occupancy, Applications - Conductivity of metals, Magnetic insectptibility, Hall effect, Thermionic emission..... etc.

Qualitative ideas of formation of bands - (E - k diagram), Classification of solides - as conductors, semi-conductors, and insulators on the basis of band diagram, Direct and indirect band gaps, Semiconductor Physics and devices - Intrinsic and Extrinsic semiconductors, Current transport in Semiconductors, Dependence of electrical conductivity on temperature, Impurity concentration levels, Qualitative ideas of fermi energy in semi conductor and effect of doping on it. P-N junction - Formation of potential barriers, Transport of electrons and holes under thermal equilibrium and with bias, **I-V** Characteristic, Junction Capacitance, Avalanche and Zener breakdown, Zener diode, Varactor diode, Light emitting diode, photo diode, Solar cell, Junction transistors - Structure, Biasing, Amplification (Common Emitter Characteristics), Switching.

Junction FET - Construction, Operation, Applications.

Uni Junction Transistor - Construction , Operation, Application.

8) Electronics -

Norton Theorem, Thevinin's theorem.

Diodes circuit - Half wave and full wave rectifiers, Bridge circuit, Ripple factor, Shunt capacitance filter, Switch, Silicon controlled rectifiers, Shunt regulated (zener) rectifier, Series regulators. Clippers and Clampers.

Transistors - Four terminal network - Hybrid parameters, Junction transistors and JFET, circuit.

Small Signal Amplifier's - Biasing configuration (C E, C B and C C) and their characteristics, g_m, R_i, R_o, A_i and power gain, Feed back in amplifiers, frequency response (Qualitative), current amplifier - Darlington pairs.

Operational Amplifier - I/O impedance, inverting and Non-inverting gains. Input offset current. Input offset voltage, CMRR and their measurement. Applications - adder, subtractor, comparator, integrator and differentiator.

Oscillators - Barkhausen criteria, Colpit and Hartley oscillators, phase shift oscillator, Monostable, Bistable and Astable multivibrators, Relaxation oscillators, Wave form generators, timer.

Digital electronics - Boolean Algebra - Binary numbering system - addition, substraction, multiplication, identities - De morgan's theorems, Logic gates and their truth tables, simple logic circuits.

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ZOOLOGY (OPTIONAL)
(CODE No. 609)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) Cell Biology :
Prokaryotic and Eukaryotic cells. Ultra structure of cell orgranelles and their functions, Cell membrane, Mitochondria, Golgi apparatus, Lysosomes, Nuclear membrane, cytoskeleton, Smooth and Rough endoplasmic reticulum. Cell cycle-Mitosis and Meiosis. Cell mediated immunity.

2) Genetics and Evolution:
Mendelian Genetics - Basic Principles, concept of dominance, Linkage, sex linkage, linkage maps and their construction, penetrance and expressivity.
Mutations at gene function, DNA and chromosome levels. Mechanisms of Mutagenesis.
Population Genetics - Hardy Weinberg Principle and its applications.
The Human genome project, its importance and impact.
Evolution : Lamarkian and Darwinian, views on evolution. Current status. Mechanisms of evolution **-** sympatric, allopatric and parapatric speciation. Evolution at molecular level. Construction of phylogenetic trees using molecular data.(Cytochrome, myoglobin etc.).

3) Biostatistics : Probability theory. Probability distributions, and their properties. Hypothesis testing. Analysis of frequencies. Analysing variance, correlation, Coefficient of variance, Regression, student t' test, Chi**-**squre test, their importance and uses**.** Measures of Central tendency : mean, meadian and mode. Measures of dispersion. Standard deviation, co-relation coefficient, coefficient of variance and coefficient of Standard deviation and error.

SECTION - B

1) Biochemistry : Structure of atom, structure of molecule and chemical bonds. Structure of water and its biological importance.
Molecules of life : Proteins, lipids, carbohydrates, nucleic acids, their structures, properties and biological importance.
Enzymes : Classification, properties, functions and mode of actions.
Bioenergetics

2) Molecular Biology : Central dogma in molecular Biology and its significance. DNA as genetic material, its suitability to be genetic material. Structure of DNA A,B, & Z configurations of structure.
DNA replication - mechanism : DNA repair mechanism. Structure of RNA. Types of RNAs and their roles.
Transcription - Mechanism. Transcription unit. its organization. Introns and exons. Post transcriptional RNA modifications...
Translation - Mechanism, Initiation and termination. Post translational modification.
Genetic code and its properties. Regulation of gene function; Operons**-**inducible, repressible operons. Control by attenuation.

3) Bio-informatics : Historical perspective on computers and their application to biological systems, DOS, Windows, Unix. Introduction to programming. The internet and the biologist. Data bases and information, retrieval, sequence analysis, basic concepts and operational aspects phylogentic analysis, predictive methods based on sequence data, Genome information.
Biotechnology : Basic concepts in genetic engineering. Enzymology of genetic engineering. Restriction enzymes, DNA ligase, polymerase etc. Methods for introduction of foreign genes in cells - Transformation, transduction, liposomes, Electroporation, microinjection. Cloning vehicles, plasmids, consmids , Lambda phage, shuttle vectors, yeast plamids. Artificial chromosomes, Analysis and expression of cloned genes in host cells. Restriction enzyme analysis, Southern blotting, Northern blotting, DNA sequencing, DNA finger printing, polymerase chain reaction, Construction of gene libraries.

SECTION - C

1) Physiology of vertebrates : Physiology of the Thermoregulation, Circulation, Nutrition and Digestion, Nervous system and sense organs, Muscle Contraction, Reproduction, Endocrine glands. Hormones and their roles.

2) Developmental Biology : Gametogenesis, ultrasturcture of mammalian sperm. Types of eggs. Process of fertilization, types of cleavages. Blastulation, Gastrulation. Germ layers establishment and their fates. Concept of determination and induction. Role of cytoplasm and nucleus in early embryonic development. Homeotic genes. Study of embryonic development of frog and of chick (upto 96 hours of development).

3) Applied Zoology : Principles and practices and economic importance of marine and fresh water fisheries, Apiculture, Sericulture. Human diseases, diseases caused by protozoons and through arthropod vectors.

SECTION - D

1) Non-Chordates : Major phyla, Classification upto orders, with basis of classification and their characters.

Phylum-wise Studies

Protozoa : Sexual and asexual reproduction, Symbiotic and parasitic protozoon. Locomotory organs, their structure, ultrasturcture. Ciliary movements.

Porifera : Systematic position, Porifera as a unique group.

Coelenterata : Polymorphism in Coelenterata, Coral reefs, Life history and alternation of generations in obelia and Aurelia, Nemotocysts- Types, structure and functions.

Ctenophora : Systematic position, Structure and peculiarities

Platyhelminthes : Parasitic adaptations, Life cycle of liver fluke and Taenia solium.

Aschelminthes : Parasitic adaptations in round worms, Life cycle studies of Ancylostoma, Wuchereria, Trichinella

Annelida : Advent of coelum, Metamerism in Annelida, Annelida diversity.

Arthropoda: Metamerism in Arthropoda, Crustacean larvae, Feeding and mouth parts of insects, Studies of social insects, Control of insect pests.

Mollusca : Shell in mollusca, Tortion and Detorsion in mollusca, Foot in mollusca.

2) Chordates

Classification upto orders, basis of classification and characteristics. Class-wise Study **:**

Fishes : Dipnoi, Scales in fishes, Migration in fishes.

Amphibia : Neoteny, Parental care in Amphibia.

Reptiles : Rhyncocephalia, the living fossil. Poisonous and nonpoisonous snakes, Skull characteristics of reptiles.

Birds : Flying adaptations, Types of feathers, Flight muscles, Migration in birds.

Mammals : Origin of mammals, Types of eggs, Types of placentae, Endocrine glands, Structure of sense organs, Dentition, Histology of mammalian tissues.

3) Systematics : Definition and scope of systematics, Biological classification, Basis of five Kingdom classification, Biological nomenclature of species, Species concept - Essentialistic, nominalistic concepts. Current status**.**

4) Environmental Biology : Biospheres and their physical features and food pyramids. Ecosystems and their energetics, Trophic levels as pyramids (Number, Biomass, Energy); Biogeochemical cycles of Nitrogen, Carbon and phosphorus, Aquatic and terrestrial communities and their dynamics, Biodiversity - Current levels of biodiversity, alpha and beta biodiversity, Extinction, endangered species. Significance of biodiversity and steps in preservation of biodiversity.

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STATISTICS (OPTIONAL)
(CODE No. 608)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) PROBABILITY

Sample space and events. Probability and probability space. Random variable : Discrete Probability distributions : Probability mass function (pmf), cumulative distribution function (c.d.f.), mean median and mode. Independence of events and random variable. Theorem on additive & multiplicative law of probability. Expectation and moments of random variables, moment generating function (m.g.f.) and its properties. Probability generating function (p.g.f.) and their properties. Measures of dispersion and skewkness.

Univariate Continuous Distributions. Definition of Continuous random variable (r.v.). Probability density function (p.d.f), cumulative distribution function (c.d.f) of continuous random variable. Expectation, raw and central moments, moments generating function (m.g.f.), Joint probability law, marginal and conditional distribution.

2) STANDARD DISCRETE AND CONTINUOUS DISTRIBUTION :

i. Binomial distribution.
ii. Poisson distribution.
iii. Geometric distribution.
iv. Negative Binomial distribution.
v. Multinomial distribution.

Normal distribution with mean m and variance σ^2 ; moments, quartiles, Mode, median, mgf , additive property. Computation of probabilities using normal probability tables. Normal approximation to binomial and Poisson distributions.

3) OTHER CONTINUOUS DISTRIBUTIONS :

i) Exponential distribution, with mean θ , mgf, nature of Probability curve, median, quartiles, lack of memory property.

ii) Gamma distribution, $X \sim G(\alpha, \lambda)$ Special cases (i) α -1 (ii) λ - 1, moments, mode, additive property, Relationship with Poisson and exponential distribution.

iii) Beta distribution of first kind $X \sim \beta_1(m,n)$nature of probability curve, mean and variance. Uniform distribution as a special case, m=n=1.

iv) Beta distribution of second kind $X \sim \beta_2(m,n)$,Its mean and variance Distribution of X/Y and X/X+Y where x and y are independent gamma variates

v) Chi Square (X^2)Distribution: Chi Square (X^2)Distributionas a sum of squares of ni.i.d. standard normal variates.

vi) 't' distribution : defintion and use of 't' tables for calculation of probabilities.

vii) 'F' distribution : definition and use of F table for calculation of probabilities.Inter-relations among normal, x^2, t and F variates.

SECTION - B

1) SAMPLING THEORY:

An outline of fixed population and distinctive features of finite population. Simple random sampling with and without replacement, stratified random sampling, systematic sampling and cluster sampling. Ratio and regression methods of estimation involving one auxiliary variable. Probability proportional to size sampling with replacement. Non-response and non-sampling errors.

2) DESIGN OF EXPERIMENTS :

Principles of the Design of Experiments. Analysis of variance in one way and two way classification with equal number of observations per cell. Analysis of (ANCOVA) with one concomitant variable.

Analysis of Block Designs : CRD, RBD and LSD. 2^3 factorial designs, Yate's Method. Concept of confounding

3) Multiple Linear Regression and Multiple and Partial Correlation :

Notion of multiple linear regressions, (trivariate case - sample data only), Fitting of regression planes by the method of least squares, solution of normal equations. Computation of partial regression coefficient, multiple correlation coefficient and partial correlation coefficient.

Bivariate Normal distribution. Marginal and conditional distributions.

Order statistics for a random sample of size n from continuous distribution. Distribution of the i th order statistics **x (i)**. Particular cases for i = 1, and i = n for uniform and exponential distributions.

SECTION - C
STATISTICAL INFERENCE

1) Point estimation of a Parameter and its interval estimation:

Unbiased and biased estimators. Relative efficiency of two estimators. Notion of uniformly minimum variance Unbiased estimator (UMVUE). Concept and definition of sufficiency & consistency. Definition of likelihood as a function of the parameter θ for a random sample from (i) discrete (ii) continuous distribution. Definition of information function. Cramer-Rao inequality. Minimum variance bound unbiased estimator.

2) Method of Estimation:

Derivation of maximum likelihood estimators (m.l.e) for parameters of standard distributions with one parameter**.** Case of two unknown parameters for normal distribution. Derivation of m.l.e. of θ for uniform $(O, \tilde{\theta}$ The location parameter of exponential distribution. when $X \rangle \tilde{\theta}$Method of moments.

Interval Estimation**:** Confidence interval for the following cases -

i) Mean μ of normal distribution (σ^2 known and σ^2 unknown)

ii) variance σ^2 of normal distribution (μ known and μ unknown)

iii) difference of two means $\mu_1 - \mu_2$ for samples from two independent normal populations.

vi) Population proportion and difference of two population proportions in case of two independent large samples.

3) Parametric and Non-parametric tests:

Statistical hypothesis, simple and composite hypothesis **,** critical region, type I and type II errors, level of significance, size of a test and power of a test.

Neyman-Pearson lemma for simple hypothesis against simple alternative and problems based on it.

Chi square test for contigency table and goodness of fit.

Concept of distribution free statistics. Sign test, Wilcoxon signed rank tes, Mann-Whitney test, Median test and Run test.

SECTION - D

1) OPERATIONS RESEARCH:

Linear Programming (L.P.) Canonical and standard form, basic feasible solution, degenerate solution, an optimal solution. Solution of L.P. problem (LPP) by graphical method, Simplex method. Unbounded solution Big - M. method. Writing dual of a primal problem, Solution of a LPP by using its dual problem. Transportation and assignment problems. Optimal solution. Critical Path method (CPM) and project evaluation and review technique (PERT). Replacement models. Replacement of item that deteriorates with time when value of money remains same.

2) Time Series Analysis and Index numbers :

Components of Time Series **:-** trend, seasonal, cyclical and irregular (error). Additive and multiplicative models. Method of estimating trend and seasonal component.

Meaning and utility of price index numbers. Unweighted and weighted price index numbers using aggregate method. Commonly used index numbers. Time reversal, factor reversal and circular test. Consumer price index number using family budget method and aggregate expenditure method.

3) INDUSTRIAL STATISTICS:

Statistical process control (SPC): Online process control method by control charts, off line control methods by sampling schemes. Control charts for variables and attributes. R chart and $\bar{X}$ chart. P chart when subgroups are of same size and different size.

Acceptance sampling for attributes: Single and double sampling plans. Graphical determination of Average. Outgoing Quality Limit (AOQL), Operating Characteristic (OC) curve. Average sample Number (ASN) curve use of Dodge Roming tables.

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FORESTRY (OPTIONAL)
(CODE No. 106)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

Section - A

01. Silviculture General :

Silviculture - objective, scope and role of Siliviculture in forest management**.** Forest types of India and their distribution. Natural regeneration - Definition and methods of regeneration, natural regeneration from seed and vegetative parts**.** Artificial regeneration- Definition and objectives, thining and its types**.** Afforestation of difficult sites and waste land. Nursery location and design consideration, types of nursery beds and their preparation. Cultural practices for bare rooted and containerised seedlings, Transplanting and field planting methods.

02. Silvicuture System :

Definition, Scope and classification of Silviculture System. High and low forest system. Choice of Silviculture System. Details of regeneration under various systems**.** Silviculture system**--**clear felling, uniform, shelter wood, selection felling and copice. Silvics of teak, bamboo, and mixed forest. Enrichment methods and technical constraints.

03. Silviculture of trees and mangrove :

General discription, Growth and Silviculture character and regeneration methods of important species Viz, teak, Sissoo, Acacia sp, Albezzia sp, shivan, Neem, Mahua, Terminalia sp, bamboo, sandal wood and exotic species viz, Casuarina, Australian babul, Eucalyptus, Subabul and Prosopis spp.
mangroves - habitant and characteristics.

SECTION - B

01. Agro forestry, Social Forestry and Joint Forest Management and Tribology

Agroforestry - Importance and scope of Agroforestry with relevance to the need of rural community. Classification of agroforestry system. Economic gains from agroforestry, advantages and constraints of agroforestry practices. Interaction of trees with field crops and pasture. Management of agroforestry systems as regards lopping, pollarding, thinning, pruning and other cultural practices, Raising of windbreaks, Shelter belts and farm wood lots. Multipurpose and Nitrogen fixing tree species.

Social Forestry - Objectives, benefits and Scope in India. Role of social forestry in rural development, peoples participation, Joint forest management - principles, objectives and methodology. Role of non government organisation in joint forest management. Tribology - definition, concept of anthropology, types, distribution and demography of tribes. Tribals and forest - their symboiotics relationships, triabal exploitation by contractors, middleman and traders. Important tribes of India - Bhil, Gond, Korku, Madia and nomadic tribes.

02. Forest Soil, Soil conservation and watershed management :

Forest Soil - Physical and chemical properties of forest soil. Soil organic matter, characteristics of saline, alkaline, calcareous, acidic and submerged soils. Soil profile, mechanical composition of soil, forest soil compared to agriculture soil. Soil fertility and productivity, Essential nutrients - macro and micro, deficiency symptoms of certain nutrients, nutrient cycling in forest ecosystem, silvicultural implication of nutrient cycling.

Soil conservation -causes of soil erosion, **types** - wind and water erosions. Role of forest , wind break and shelter belts in conserving soil.

Watershed management - Concepts, definition, characteristics and steps in watershed management. Evaluation of watershed management, water and soil conservation measures.

03. Environmental conservation And Biodiversity :

Environment- Definition, Concept of environment, environmental complex. Plant adaptation to environment and plant indicators. Environmental pollution, **types -** air pollution, water pollution, noise pollution and soil pollution. Causes and remedy to control it. Green house effects, Role of trees and forests in environmental conservation.

Biodiversity - Definition, concept and origin of diversity. Biogeographic regions of India. Diversity of plants, animals, birds and microorganisms. Causes of loss of diversity and importance of biodiversity conservation.

04. Tree improvement and Seed technology :

Values and implementation of improvement of trees in forest management programme. Breeding methods in self and cross pollinated crops and pattern of Genetic variation in forest evolutionary process. Dangers of using exotic species, inter and intra-specific hybridisation, provenance selection and seed sources. Quantitative aspects of forest tree improvement.

Forest seed technology - Definition and its importance. Seed collection, maturity, extraction, cleaning and upgrading. Seed testing methods. Categories of certificates issued for forest seeds.

SECTION - C

01. Forest management, management system and forest working plan :

Forest management - Objectives and principles. Normal forest, sustained yield, rotation, kinds of rotation. **Increment** - kinds and importance, growing stock, growth estimation, yield regulation in regular, irregular, social forestry and agroforestry forests.

Forest working plan - Definition and objectives**.** Preliminary report, collection of data, planning and levels of planning, collection of data from field and office. Working plan organisation, control and execution of working plan. Working plan for social forestry. Role of working plan in nature conservation.

02. Forest Mensuration and Remote Sensing :

Methods of measuring diameter, girth, height and volume of trees. Form factor, volume estimation of stand, current and mean annual increment, sampling method and sample plots. Yield and stand tables.

Remote sensing - Definition, advantages of remote sensing techniques over traditional methods. Remote sensing of forest soil, forest - mapping, forest cover monitoring and damage assessment.

03. Surveying and Forest Engineering :

Forest surveying - Different methods of surveying, maps, map reading. Basic principles of Forest Engineering. Land development methods in forestry including continuous and staggered contour trenches, terracing, Water courses. their training and development.

SECTION - D

01. Forest Ecology and Ethnobotany :

Forest Ecology - definition, concept and scope. Concept of ecosystem, principles of ecology. Ecological factors - Climatic, topographic, edaphic, biotic and their effect on growth and distribution of plants and animals. Ecological succession and plant form.

Ethnobotany - Definition and scope. Ethnobotanical survey - Collection, identification and documentation. Ethnobotany of medicinal plants and their products, name of medicinal plants called by herbal vendors, botanical names, family, morphology, medicinal uses of important species viz, Aswagandha, shatavari, safed musali, jaifal, Amaltas and Dikamali.

02. Forest resources and utilisation :

Logging and extraction techniques of forest produce. Scope and importance of non-timber forest produce, its collection, processing and disposal, gums, resins, fibers, oil seeds, nuts, rubber, medicinal plants, lac, silk, katha and bidi leaves. Forest-based industries-pulp and paper, plywood, particle board, charcoal and matchsticks. Need and importance of wood seasoning and wood preservation. General principles of seasoning. Air and kiln seasoning.

03. Forest Protection and Wild Life Biology :

Forest Protection - Definition and importance of forest protection in India. Study of Nursery and Tree diseases of Teak, Sissoo, eucalyptus, Shivan, Khair, Bamboo, Casuarina and Sandal with special reference to occurrence, infection, damage, symptoms, causal organism and their management. Principles and methods of controlling tree diseases. Insect pests of trees of economics important, classification, nature and extent of damage and their management. Biology, Symptomatology and control of important plant parasitic nematodes. Study of integrated pest management **-** Concept and management through silvicultural, biological and chemical. General forest protection against fire, adverse climatic factors, man, weed, grazing and browsing animal and environmental pollution.

Wild Life Biology - Introduction, importance and history of wild life preservation. Wild life values and conflicts - aesthectics, economic, scientific, ecological and cultural/religious. Game/recreational and crop destruction. Definition of wild life management. Distribution, behaviour and adaptation of animal as affected by environmental factors. Fundamental requirement of wild life - water pinch period, shelter, territory and home range zoo**-** geographical regions of the world with special reference to wild life in India. Factors affecting animal population, concept of age and sex, mortality, morbidity, mortality density, saturation point, biological pressure and environmental resistance.

04. Forest Economics and Legislation :

Forest Economics - Fundamental, principles, cost benefits analysis, estimation of demand and supply, Analysis of trends in national and international market and changes in production and consumption pattern. Role of private sector and cooperatives, role of corporate financing. Socio**-**economic analysis of forest productivity and attitudes. Export of processed forest and other products. New economic policy - GATT in relation to export, WTO.

Legislation - History of forest development, Indian forest policy of 1894, 1952 and 1990. National forest policy of 1998 . Forest Laws - Legal definition, laws affecting harvest and transport of forest produce. Wild life legislation, wild life preservation Act - 1972, Games Act, shooting rule, Arms Act, International and national organisation, wild life conservation, other legislation relating to forest.

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HORTICULTURE (OPTIONAL)
(CODE No. 104)

STANDARD: Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

SECTION - A

1) Agricultural Botany :

Significance of agro-ecology and its relation to other disciplines, impact of horticultural practices on agro-ecosystem, irrigation and fertiliser application, natural resources and their conservation, concept of environment, ecological factors and their effects on growth and distribution of plants and animals, ecological stratification, stability, ecological succession and plant forms, environmental pollution and its effect on crop, animal and human, pollution control methods.

Mendel's work and laws of inheritance, gene interaction and linkage, chemical and physical mutagenes, role of bio-technology in crop improvement, micro-propagation, embryo culture, biopesticides and biofertilisers and their significance, absorption and translocation of water, transpiration and photosynthesis-modern concept and factors affecting the process, respiration, C_4 and CAM mechanisms.

2) Agricultural Chemistry and Soil Science :

Soil formation, physical and chemical properties of soils, soils of Maharashtra, problematic soils and their management, textural classes of soil, soil water plant relationship-field capacity, permanent wilting point, water holding capacity, soil erosion control, soil conservation, planning on watershed basis, soil and water conservation methods, insitu water harvesting, symptoms of deficiencies and toxicities of plant nutrient elements, quality of irrigation water, structure and function of cells, molecules of life, vitamins, enzymes and hormones and their mode of action, metabolism of carbohydrates, lipids and proteins.

3) Agricultural Engineering :

Farm structures- location and arrangement, farm power sources- merits and demerits, tillage and farm equipments and their maintenance, structures for protected cultivation, green house construction, types, orientation and designs, glazing materials, control of green house temperatures-methods of cooling and heating, light control, green house ventilation.

SECTION - B

1) Agricultural Economics and Extension :

Importance of horticulture in national economy, laws of consumption and production, concept of national income, renewable and non-renewable resources, horticultural development strategies, role of horticulture in five year plans, principles of farm management, farm records and farm efficiency measures, horticulture marketing- importance and functions, marketing channels and price spread, problems of marketing, scope for export of horticultural produce, role of APEDA and other agencies in export of farm products, history of co-operative movement in India, types of co-operatives and their problems , extension teaching methods and their role in transfer of technology.

2) Fruits, Plantation crops and related topics :

Importance (economic, social and nutritional), scope and branches of horticulture, soil and climatic requirements of horticultural crops, selection of site, layout of orchard, planting systems, plant nutrients and their role in growth and development, methods and principles of manuring, water requirement of fruits, irrigation principles and methods including micro-irrigation, water use efficiency in relation to crop production, orchard management practices- Sod culture, clean cultivation, cover crops, inter crops, mulching, multitier cropping, high density planting, organic farming, vermiculture, unfruitfulness, special horticultural practices, plant bio - regulators - various classes and their physiological effects on growth and development, progeny orchard, bud wood selection and certification, methods of propagation, stock scion relationship, physiology of rooting and formation of graft union, micro propagation techniques, nursery layout, propagation structures, seed and nursery act, production technology of major fruit and plantation crops like mango, banana, citrus, grapes, guava, pomegranate, ber, sapota, papaya, fig, annona, aonla, tamarind, coconut, pineapple, cashewnut, arecanut, tea, coffee, oil palm, betel vine on soil and climatic requirements, botany and other package of practices relevant to the crops.

Problems and disorders in fruit cultivation-irregular bearing, spongy tissue, malformation, citrus decline, shot, pink and mummification of berries.

SECTION - C

1) Vegetable, spices, aromatic and medicinal plants and related topics :

Importance, scope and status of vegetables and their role in human nutrition, classification of vegetables, types of vegetable gardening, cropping systems - sole cropping, rotation, intercropping, succession cropping, companion cropping, relay cropping, farming system components and their interaction, economics and evaluation of farming systems, principles and methods of weed control, seed dormancy and seed treatments, classes of seeds, isolation distance, seed certification standards, sex forms, breeding systems, crop improvement through introduction, selection, hybridisation and mutation, exploitation of hybrid vigour, gene banks & their role in genetic

conservation, recent developments in genetic resourse activities; production technology of important vegetables, spices, aromatic & medicinal crops like chilli, brinjal, tomato, potato, onion, garlic, cole crops, cucurbits, peas & beans, carrot, okra, leafy & perennial vegetables, black pepper, clove, cardamom, cinnamon, ginger, turmeric, ashwagandha, senna, shatavari, aloe, safed musali, dioscoria, vinca, citronella, lemon grass, mint, geranium, patcholi, vetivera on appropriate points like soil & climate, propagation & planting, irrigation, & manuring, special practices relevant to the crop, harvesting, yield, processing and plant protection.

2) Plant pathology :

Mushroom types, importance (economic and nutritional) and scope for mushroom cultivation, production technology of mushrooms, harvesting and preservation, recipes for products, nature and properties of plant viruses and mycoplasma, principles of plant disease control, symptoms, causes and control of various diseases of important horticultural crops.

SECTION - D

1) Ornamental horticulture, floriculture, post harvest technology and agroforestry :

Garden designs, types of gardens, garden features, landscaping, lawn making, climbers, creepers, annuals, shrubs, trees, indoor plants and their use in gardening, rockery, bonsai, ikebana, flower arrangement, extraction of essential oils from flowers, protected cultivation of flowers, their harvesting, packing & marketing, production technology of major floricultural crops like roses, chrysanthemum, gladiolus, tuberose, jasmins, gaillardia, gerbera, carnation, marigold, on relevant points like soil and climatic requirements, package of practices, harvesting, precooling, packing and storage; Harvesting and maturity indices, ripening of fruits, changes during ripening , methods of hastening and delaying ripening, post harvest losses and their control, pre & post harvest treatments, methods of pre-cooling, grading, packing, storage and transport of horticultural produce, storage structures, importance and scope for preservation, principles and methods of preservation, preparation of various preserved & processed products, spoilage of products ; importance and scope for agroforestry, advantages & limitations of agroforestry afforestation of problematic soils & other places, forest trees and crop interfaces, agroforestry systems - wind breaks and shelter belts, alley cropping, toungya systems.

2) Entomology :

Insect classification and methods of pest control, concept of IPM and other advanced techniques in pest control, nature of damage, causes and control of important pests infesting horticultural crops, effects of insecticidal residues on human & animal health, importance of sericulture in cottage industry, sericultural practices.

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ANIMAL HUSBANDRY & VETERINARY SCIENCE (OPTIONAL)
(CODE No. 105)

STANDARD : Degree
MEDIUM : English
NATURE : Conventional (Essay) type

TOTAL MARKS : 200
DURATION : Three hours

Section - A (Marks: 50)
Veterinary Anatomy, Physiology & Biochemistry and Animal Nutrition

1) Anatomy and Physiology of digestive, respiratory, cardiovascular, musculoskeletal and uro-genital system. Physiology of nervous system and sensory organs; Growth and development of embryo in livestock and poultry.
2) Physiology of digestion, absorption and metabolism of carbohydrates, proteins and fats in ruminants and non-ruminants; Anatomy and physiology of mammary gland with reference to endocrine control; Environmental physiology and its influence on growth and production.
3) Feeding and management of animals under draught, flood and other natural calamities; Standards of potable water and its supply for livestock and poultry; Methods of cultivation and conservation of fodder
4) Importance of nutrients in animal health and production; Nutrients, their role and their requirement, metabolism in livestock and poultry, Nutritional deficiency and their management.
5) Conventional and non-conventional feeds and fodder and their importance in livestock and poultry; Feeding standards, balanced ration, computing balanced ration for growth, maintenance, breeding and production of livestock and poultry.

Section - B (Marks : 50)
Animal Genetics and Breeding, Livestock & Poultry Management, Livestock Products Technology and Extension

6) Principles of animal genetics; Heritability, repeatability, genetic correlation and their applications, Hardy - Weinberg Law. Systems of mating; Inbred lines; Heterosis; Selection of breeding animals, response to selection, Importance of conservation of livestock and poultry Germplasm.
7) Chromosome complements of various productive animals; Chromosomal aberrations, their effect on fertility and productivity of livestock.
8) Breeds of cattle, buffalo, sheep, goat, pig, poultry and other commonly found animals and birds; Transportation of animals; Care and management of young stock, dry, pregnant, lactating animals, breeding animals; Dentition of animals. Identification and tracking systems for domestic and wild animals and birds.
System of housing and management of zoo/ wild animals.
9) Composition and nutritive value of milk, meat and poultry egg; Preservation and transportation of milk, meat and poultry products; Identification and differentiation of meat.
10) Concepts and principals of extension; Different methods of extension education; Evaluation of technology and its transfer to the livestock and poultry entrepreneur; farmers and industry; Communication and skill in identification of problems in dairy, poultry and meat industry; Development and execution of animal husbandry program for rural development; Involvement of unemployed women, marginal and small farmers in livestock and poultry production; Role of Krishi Vigyan Kendra and ATMA.

Section - C (Marks : 50)
Veterinary Pharmacology & Toxicology, Parasitology and Pathology, Microbiology, Animal Biotechnology and Veterinary Public Health

11) Drugs acting on central nervous system, cardiovascular system digestive system, respiratory system, urogenital system. Antimicrobial drugs, indigenous drugs and their uses; Toxicity caused by metals, non-metals, plants, agrochemicals.
12) Host - parasite relationship; Mode of transmission and dissemination of parasites; Morphology and pathogenesis of helminth parasites, arthropods, protozoan diseases affecting man, animal and poultry commonly encountered in India.
13) Collection, preservation, dispatch and transportation of biopsy and autopsy material for diagnosis of diseases in livestock and poultry as per OIE norms.
14) Types of microbial diseases; Immune system and immunity - antigens, antibodies; Serological tests, Immunization and immuno-prophylaxis; Hypersensitivity. Fungal diseases: Dermatomycosis, mycotoxicosis., Viral diseases: Pox infections, foot and mouth disease, PP, blue tongue, rabies, canine distemper, Ranikhet disease, infectious bursal disease, mareks disease, infectious bronchitis, avian influenza.
15) Various animal bio-technological techniques and their applications in veterinary and animal sciences. Meat inspection; Differentiation of meat of food animals; Food and water borne disease and food intoxication. Zoonosis, prevention and control of zoonotic diseases.

Section - D (Marks : 50)

Methods of Clinical Examinations, Veterinary Surgery and animal Reproduction

16) Clinical signs, diagnosis and treatment of hyperthermia, hypothermia, fever, septicemia, toxemia, dehydration and shock.
Vaccination protocols commonly followed in livestock and poultry; Disease reporting systems. Objectives and application of epidemiology and preventive medicine. Principles and concept of general epidemiology. Legal duties of veterinarian, common offences against animals and laws related to these offences; Legal point and examination of living and dead animals in criminal cases, cruelty to animals; injuries and postmortem examination of animals. State and Central government acts relating to animals; Code of conduct and ethics of veterinarians; Regulations of Indian Veterinary Council Act, 1984; Animal insurance.

17) Care and management of wound, abscess, tumors, cyst hernia, necrosis, gangrene, burn, frost bite, shock, dislocation and affections of joints.

18) Anesthesia and management of local, regional, general and balanced anesthesia in domestic and wild animals; Pre-anesthetic medication and management of anesthetic emergencies.

19) Puberty and sexual maturity in animals; Role of hormones in reproduction; Detection of heat; Artificial insemination; Diagnosis of pregnancy.

20) Disease and accidents of gestation; Parturition and its management; Dystokia and its treatment; Semen collection; assisted reproductive technology. conservation of wild animals.

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