

SCHEDULE – I

Clause No

I GENERAL STUDIES (COMPULSORY FOR ALL GRADE/POSTS/BRANCHES)

TOTAL MARKS – 100
Duration of examination – 1 hour

The break up of marks on various topics will be as follows:-

<u>Topic</u>	<u>Marks</u>
i) Comprehension of a given passage	20
ii) Usage (corrections)	10
iii) Vocabulary (synonyms & antonyms, idioms & phrases)	10
iv) General knowledge	20
(Questions will include knowledge of Indian and geography of such a nature which the candidates should be able to answer without any special study. Questions on Tripura, its historian topography will also be included.)	
v) Current Affairs	20
(The questions will include knowledge of Indian current events and of such matters of every day observation and experience in their scientific aspects as may be expected of an educated person who has not made a special study of any scientific subject.)	
Vi) Mental Ability.	20
Total	100

II. ENGINEERINGS SUBJECT PAPER – I & II(OPTIONAL FOR ALL GRADES /RANCHES)

TOTAL MARKS – 200(each paper)
Duration of examination – 3 hour

The break up of marks will be as follows:

<u>Topic</u>	<u>Marks</u>
i) 15 questions of 6 marks each having answers restricted to 40 words	90
ii) 40 multiple choice type questions of 2 marks each	80
iii) 05 numerical questions of 6 marks each	30
Total	200

SCHEDULE-II

Syllabus for Grade IV/ Assistant Engineer

CIVIL ENGINEERING PAPER - I

**Total Marks – 200
Duration of Examination – 3 Hours**

1. BUILDING MATERIALS

Timber : Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.

Bricks: Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.

Cement: Compounds of, different types, setting times, strength.

Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry.

Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods.

2. SOLID MECHANICS

Elastic constants, stress, plane stress, Mohr's circle of stress, strains, plane strain, Mohr's circle of strain, combined stress; Elastic theories of failure; Simple bending, shear; Torsion of circular and rectangular sections and simple members.

3. DESIGN OF STEEL STRUCTURES

Principles of working stress method. Design of connections, simple members, Built-up sections and frames, Design of Industrial roofs. Principles of ultimate load design. Design of simple members and frames.

4. DESIGN OF CONCRETE AND MASONRY STRUCTURES

Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Working stress method of design of R.C. members.

Principles of prestressed concrete design, materials, methods of pre stressing, losses. Design of simple members and determinate structures. Introductions to prestressing of indeterminate structures.

Design of brick masonry as per I.S. Codes.

5. CONSTRUCTION PRACTICES, PLANNING AND MANAGEMENT

Concreting Equipment: Weight Batcher, Mixer, vibrator, batching plant, concrete pump. Cranes, hoists, lifting equipment.

Earthwork Equipment: Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.

Construction, Planning and Management: Bar chart, linked bar chart, work-break down structures, Activity-on - arrow diagrams. Critical path, probabilistic activity durations; Event-based networks.

PERT network: Time-cost study, crashing; Resource allocation.

**CIVIL ENGINEERING
PAPER - II**

**Total Marks - 200
Duration of Examination – 3 Hours**

1. (a) FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW:

Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Drag, Lift; dimensional Analysis, Modeling; Cavitation; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows, Measurements; Siphons; Surges and Water hammer; Delivery of Power Pipe networks.

(b) HYDRAULIC MACHINES AND HYDROPOWER:

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps, air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

2. (a) HYDROLOGY:

Hydrological cycle, precipitation and related data analyses, PMP, unit and synthetic hydrographs; Evaporation and transpiration; Floods and their management, PMF; Streams and their gauging; River morphology; Routing of floods; Capacity of Reservoirs.

(b) WATER RESOURCES ENGINEERING:

Multipurpose uses of Water: Soil-Plant-Water relationships, irrigation systems, water demand assessment; Storages and their yields, ground water yield and well hydraulics; Water logging, drainage design; Irrigation revenue; Design of rigid boundary canals, lining of canals; Sediment transport in canals; Non-Overflow and overflow sections of gravity dams and their design, Energy dissipaters and tail water rating; Design of head works, distribution works, falls, cross-drainage works, outlets; River training.

3. ENVIRONMENTAL ENGINEERING

(a) WATER SUPPLY ENGINEERING:

Sources of supply, yields, design of intakes and conductors; Estimation of demand; Water quality standards; Control of Water-borne diseases; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance and distribution systems of treated water, leakages and control; Rural water supply; Institutional and industrial water supply.

(b) WASTE WATER ENGINEERING:

Urban rain water disposal; Systems of sewage collection and disposal; Design of sewers and sewerage systems; pumping; Characteristics of sewage and its treatment, Disposal of products of sewage treatment, stream flow . Plumbing Systems, Rural and semi-urban sanitation.

(c) SOLID WASTE MANAGEMENT:

Sources, classification, collection and disposal; Design and Management of landfills

4 (a) SOIL MECHANICS:

Properties of soils, classification and interrelationship; Compaction behavior, methods of compaction and their choice; Permeability and seepage, flow nets, Inverted filters; Compressibility and consolidation; Shearing resistance, stresses and failure; soil testing in laboratory and in-situ; Stress path and applications; Earth pressure theories, stress distribution in soil; soil exploration, samplers, load tests, penetration tests.

(b) FOUNDATION ENGINEERING:

Types of foundations, Selection criteria, bearing capacity, settlement, laboratory and field tests; Types of piles and their design and layout, Foundations on expansive soils, swelling and its prevention, foundation on swelling soils.

5. (a) SURVEYING:

Classification of surveys, scales, accuracy; Measurement of distances - direct and indirect methods; optical and electronic devices; Measurement of directions, prismatic compass, local attraction; Theodolites - types; Measurement of elevations - Spirit and trigonometric leveling; Relief representation; Contours; Digital elevation modeling concept; Establishment of control by triangulations and traversing - measurements and adjustment of observations, computation of coordinates; Field astronomy, Concept of global positioning system; Map preparation by plane tabling and by photogrammetry; Remote sensing concepts, map substitutes.

(b) TRANSPORTATION ENGINEERING:

Planning of highway systems, alignment and geometric design, horizontal and vertical curves, grade separation; Materials and construction methods for different surfaces and maintenance: Principles of pavement design; Drainage.

Traffic surveys, Intersections, signaling; Mass transit systems, accessibility, networking.

**MECHANICAL ENGINEERING
PAPER – I**

**Total Marks - 200
Duration of Examination – 3 Hours**

1. STRENGTH OF MATERIALS:

Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams: Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. . Torsion of shafts, helical springs. Combined stresses, thick-and thin-walled pressure vessels. Struts and columns. Strain energy concepts and theories of failure.

2. FLUID MECHANICS.

Properties and classification of fluids, Manometer, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Similitude and modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shock-wave.

3. THEORY OF MACHINES:

Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines. Critical speeds and whirling of shafts Automatic controls.

4. MACHINE DESIGN:

Design of Joints: Cotters, keys, Splines, Welded joints, Threaded fasteners, joints formed by interference fits. Design of friction drives: couplings and clutches, belt and chain drives, power screws.

Design of Power transmission Systems: gears and gear drives shaft and axle, wire ropes.

Design of Bearings: hydrodynamics bearings and rolling element bearings.

5. FLUID MACHINERY AND STEAM GENERATORS:

Performance, Operation and control of hydraulic Pump, impulse and reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmission, Steam generators, Fire-tube and water-tube boilers. Flow of steam through Nozzles and Diffusers, Wetness and condensation. Various types of steam and gas Turbines. Partial admission. Reciprocating, Centrifugal and axial flow Compressors, Multistage compression, role of Mach Number, Reheat, Regeneration, Efficiency, Governance.

MECHANICAL ENGINEERING
PAPER –II

Total Marks –200
Duration of Examination – 3 Hours

1. THERMODYNAMICS:

Cycles and IC Engines, Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processes. Entropy, Availability. Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Pre-ignition, Detonation and Diesel-knock, Fuel injection and Carburetion, Supercharging. Turbo-prop and Rocket engines, Engine Cooling, Emission & Control. Measurement of Calorific values. Conventional and Nuclear fuels, Elements of Nuclear power production.

2. HEAT TRANSFER, REFRIGERATION AND AIR-CONDITIONING:

Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, Thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor.. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigeration, controls, Duct design.

3. ENGINEERING MATERIALS:

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

4. INDUSTRIAL ENGINEERING:

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

Control Operations: Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement, Quality Management - Quality analysis and control.

Operations Research: Linear Programming - Graphical and Simplex methods, Transportation and assignment models.

Value Engineering: Value analysis for cost/value.

**ELECTRICAL ENGINEERING
PAPER – I**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. EM THEORY:

Electric and magnetic fields. Gauss's Law and Amperes Law. Fields in dielectrics, conductors and magnetic materials. Time varying fields. Plane-Wave propagating in dielectric and conducting media. Transmission lines.

2. ELECTRICAL MATERIALS:

Conductors, Semi-conductors and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors

3. ELECTRICAL CIRCUITS

Circuits elements. Kirchoff's Laws. Mesh and nodal analysis. Network Theorems and applications. Natural response and forced response. Transient response and steady state response for arbitrary inputs. Properties of networks in terms of poles and zeros. Transfer function. Resonant circuits. Threephase circuits. Two-port networks. Elements of two-element network synthesis.

4. MEASUREMENTS AND INSTRUMENTATION

Units and Standards. Measurement of current, Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, Capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems. A/D and D/A converters.

5. CONTROL SYSTEMS.

Block diagrams and signal flow graphs and their reduction. Errors for different type of inputs and stability criteria for feedback systems. Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable matrix and its use in system modelling and design. Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Elements of non-linear control analysis. Control system components, electromechanical, hydraulic, pneumatic components.

**ELECTRICAL ENGINEERING
PAPER – II**

**Total Marks - 200
Duration of Examination – 3 Hours**

1. ELECTRICAL MACHINES AND POWER TRANSFORMERS.

Magnetic Circuits. Construction and testing. Equivalent circuits. Losses and efficiency. Regulation. Auto-transformer, 3-phase transformer. Parallel operation.

Basic concepts in rotating machines. EMF, torque, basic machine types. Construction and operation, leakage losses and efficiency.

B.C. Machines. Construction, Excitation methods. Circuit models. Armature reaction and commutation. Generators and motors. Starting and speed control. Testing, Losses and efficiency.

Synchronous Machines. Construction. Circuit model. Operating characteristics. Synchronous reactance. Efficiency. Voltage regulation. Salient-pole machine, Parallel operation. Hunting. Short circuit transients.

Induction Machines. Construction. Principle of operation. Rotating fields. Characteristics and performance analysis. Determination of circuit model. Circle diagram. Starting and speed control. Fractional KW motors. Single-phase synchronous and induction motors.

2. POWER SYSTEMS

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors. Power transmission. lines. Modeling and performance characteristics. Voltage control. Load flow studies. Optimal power system operation. Load frequency control. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion. Power system Transients. Power system Protection Circuit breakers. Relays. HVDC transmission.

3. ANALOG AND DIGITAL ELECTRONICS AND CIRCUITS

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors. Small signal amplifiers, biasing circuits, frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers, Oscillators. Large signal amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits. Multivibrators and flip-flops and their applications. Digital logic gate families, universal gates-combination circuits for arithmetic and logic operational, sequential logic circuits. Counters, registers, RAM and ROMs.

4. MICROPROCESSORS

Microprocessor architecture-Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Microprocessors in power system.

5. COMMUNICATION SYSTEMS

Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

6. POWER ELECTRONICS

Power Semiconductor devices. Thyristor. Power transistor, GTOs and MOSFETS. Characteristics and operation. AC to DC Converters; 1-phase and 3-phase DC to DC Converters; AC regulators. Thyristor controlled reactors; switched capacitor networks. Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies.

SCHEDULE - III
Syllabus for Grade V (A)/Junior Engineer(Degree holder)
CIVIL ENGINEERING
PAPER – I

Total Marks – 200
Duration of Examination – 3 Hours

1. BUILDING MATERIALS

Timber: Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.

Bricks: Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.

Cement: Compounds of, different types, setting times, strength.

Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry.

Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods

2. SOLID MECHANICS:

Elastic constants, stress, plane stress, Mohr's circle of stress, strains, plane strain, Mohr's circle of strain, combined stress; Elastic theories of failure; Simple bending, shear; Torsion of circular and rectangular sections and simple members.

3. DESIGN OF STEEL STRUCTURES:

Principles of working stress method. Design of connections, simple members, Built-up sections and frames, Design of Industrial roofs. Principles of ultimate load design.

4. DESIGN OF CONCRETE AND MASONRY STRUCTURES:

Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Working stress method of design of R.C. members.

Principles of prestressed concrete design, materials, methods of prestressing, losses. Design of simple members and determinate structures.

5. CONSTRUCTION PRACTICES, PLANNING AND MANAGEMENT:

Concreting Equipment: Weight Batcher, Mixer, vibrator, batching plant, concrete pump. Cranes, hoists, lifting equipment.

Earthwork Equipment: Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.

Construction, Planning and Management: Bar chart, linked bar chart, work-break down structures, Activity - on - arrow diagrams. Critical path, probabilistic activity durations; Event-based networks.

**CIVIL ENGINEERING
PAPER – II**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. (a) FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW:

Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Drag, Lift; dimensional

Analysis, Modeling; Cavitation; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows, Measurements; Siphons; Surges and Water hammer.

(b) HYDRAULIC MACHINES AND HYDROPOWER:

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps, air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

2. (a) HYDROLOGY:

Hydrological cycle, precipitation and related data analyses, PMP, unit and synthetic hydrographs; Evaporation and transpiration; Floods and their management, PMF; Streams and their gauging.

(b) WATER RESOURCES ENGINEERING:

Multipurpose uses of Water: Soil-Plant-Water relationships, irrigation systems, water demand assessment; Storages and their yields, ground water yield and well hydraulics; Water logging, drainage design; Irrigation revenue.

3. ENVIRONMENTAL ENGINEERING

(a) WATER SUPPLY ENGINEERING:

Sources of supply, yields, design of intakes and conductors; Estimation of demand; Water quality standards; Control of Water-borne diseases; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance and distribution systems of treated water, leakages and control; Rural water supply; Institutional and industrial water supply.

(b) WASTE WATER ENGINEERING:

Urban rain water disposal; Systems of sewage collection and disposal; Design of sewers and sewerage systems; pumping; Characteristics of sewage and its treatment, Disposal of products of sewage treatment, stream flow . Plumbing Systems, Rural and semi-urban sanitation.

(c) SOLID WASTE MANAGEMENT:

Sources, classification, collection and disposal; Design and Management of landfills.

4 (a) SOIL MECHANICS:

Properties of soils, classification and interrelationship; Compaction behaviour, methods of compaction and their choice; Permeability and seepage, flow nets, Inverted filters; Compressibility and consolidation; Shearing resistance, stresses and failure; soil testing in laboratory and in-situ; Stress path and applications; Earth pressure theories, stress distribution in soil; soil exploration, samplers, load tests, penetration tests.

(b) FOUNDATION ENGINEERING:

Types of foundations, Selection criteria, bearing capacity, settlement, laboratory and field tests; Types of piles and their design and layout, Foundations on expansive soils, swelling and its prevention, foundation on swelling soils.

5. (a) SURVEYING:

Classification of surveys, scales, accuracy; Measurement of distances - direct and indirect methods; optical and electronic devices; Measurement of directions, prismatic compass, local attraction; Theodolites - types; Measurement of elevations - Spirit and trigonometric leveling; Relief representation; Contours; Digital elevation modelling concept; Establishment of control by triangulations and traversing - measurements and adjustment of observations, computation of coordinates; Field astronomy, Concept of global positioning system.

(b) TRANSPORTATION ENGINEERING:

Planning of highway systems, alignment and geometric design, horizontal and vertical curves, grade separation; Materials and construction methods for different surfaces and maintenance; Principles of pavement design; Drainage.

**MECHANICAL ENGINEERING
PAPER – I**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. STRENGTH OF MATERIALS:

Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams : Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, thick-and thin-walled pressure vessels. Struts and columns.

2. Fluid Mechanics:

Properties and classification of fluids, Manometer, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Similitude and modelling.

3. THEORY OF MACHINES:

Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines. Critical speeds and whirling of shafts Automatic controls.

4. MACHINE DESIGN:

Design of Joints: cotters, keys, splines, welded joints, threaded fasteners, joints formed by interference fits. Design of friction drives: couplings and clutches, belt and chain drives, power screws.

Design of Power transmission systems: gears and gear drives shaft and axle, wire ropes.

Design of bearings: hydrodynamics bearings and rolling element bearings.

5. FLUID MACHINERY AND STEAM GENERATORS:

Performance, Operation and control of hydraulic Pump, impulse and reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmission, Steam generators, Fire-tube and water-tube boilers. Flow of steam through Nozzles and Diffusers, Wetness and condensation. Various types of steam

and gas Turbines. Partial admission. Reciprocating, Centrifugal and axial flow Compressors, Multistage compression, role of Mach Number, Reheat, Regeneration, Efficiency, Governance.

**MECHANICAL ENGINEERING
PAPER – II**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. THERMODYNAMICS:

Cycles and IC Engines, Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processes. Entropy, Availability. Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Pre-ignition, Detonation and Diesel-knock, Fuel injection and Carburation, Supercharging. Turbo-prop and Rocket engines, Engine Cooling, Emission & Control. Measurement of Calorific values.

2. HEAT TRANSFER, REFRIGERATION AND AIRCONDITIONING:

Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, Thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor.. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigeration, controls, Duct design

3. ENGINEERING MATERIALS:

Basic concepts on structure of solids. Crystalline materials. Defects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials.

4. INDUSTRIAL ENGINEERING:

Production Planning and Control: Forecasting - Moving average, exponential smoothing, Operations, scheduling; assembly line balancing, Product development, Break-even analysis, Capacity planning, PERT and CPM. Control Operations: Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement

**ELECTRICAL ENGINEERING
PAPER – I**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. EM THEORY:

Electric and magnetic fields. Gauss's Law and Amperes Law. Fields in dielectrics, conductors and magnetic materials. Time varying fields. Plane-Wave propagating in dielectric and conducting media. Transmission lines.

2. ELECTRICAL MATERIALS:

Conductors, Semi-conductors and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors.

3. ELECTRICAL CIRCUITS

Circuits elements. Kirchoff's Laws. Mesh and nodal analysis. Network Theorems and applications. Natural response and forced response. Transient response and steady state response for arbitrary inputs. Properties of networks in terms of poles and zeros. Transfer function. Resonant circuits. Threephase circuits. Two-port networks. Elements of two-element network synthesis.

4. MEASUREMENTS AND INSTRUMENTATION

Units and Standards. Measurement of current, Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, Capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems. A/D and D/A converters.

5. CONTROL SYSTEMS.

Block diagrams and signal flow graphs and their reduction. Errors for different type of inputs and stability criteria for feedback systems. Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable matrix and its use in system modelling and design. Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Elements of non-linear control analysis. Control system components, electromechanical, hydraulic, pneumatic components.

**ELECTRICAL ENGINEERING
PAPER – II**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. ELECTRICAL MACHINES AND POWER TRANSFORMERS.

Magnetic Circuits . Construction and testing. Equivalent circuits. Losses and efficiency. Regulation. Auto-transformer, 3-phase transformer. Parallel operation.

Basic concepts in rotating machines. EMF, torque, basic machine types. Construction and operation, leakage losses and efficiency.

B.C. Machines. Construction, Excitation methods. Circuit models. Armature reaction and commutation. Generators and motors. Starting and speed control. Testing, Losses and efficiency.

Synchronous Machines. Construction. Circuit model. Operating characteristics. Synchronous reactance. Efficiency. Voltage regulation. Salient-pole machine, Parallel operation. Hunting. Short circuit transients.

Induction Machines. Construction. Principle of operation. Rotating fields. Characteristics and performance analysis. Determination of circuit model. Circle diagram. Starting and speed control. Fractional KW motors. Single-phase synchronous and induction motors.

2. POWER SYSTEMS

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors. Power transmission lines. Modeling and performance characteristics. Voltage control. Load flow studies. Optimal power system operation. Load frequency control. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion. Power system Transients. Power system Protection Circuit breakers. Relays. HVDC transmission.

3. ANALOG AND DIGITAL ELECTRONICS AND CIRCUITS

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors. Small signal amplifiers, biasing circuits, frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers, Oscillators. Large signal amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits. Multivibrators and flip-flops and their applications. Digital logic gate families, universal gates-combination circuits for arithmetic and logic operational, sequential logic circuits. Counters, registers, RAM and ROMs.

4. MICROPROCESSORS

Microprocessor architecture-Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Micro-processors in power system.

5. COMMUNICATION SYSTEMS

Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

6. POWER ELECTRONICS

Power Semiconductor devices. Thyristor. Power transistor, GTOs and MOSFETS. Characteristics and operation. AC to DC Converters; 1-phase and 3-phase DC to DC Converters; AC regulators. Thyristor controlled reactors; switched capacitor networks. Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies.

SCHEDULE - IV

Syllabus for Grade V (B) Junior Engineer(Diploma holder)

CIVIL ENGINEERING PAPER – I

Total Marks – 200

Duration of Examination – 3 Hours

1. BUILDING MATERIALS & CONSTRUCTION:

BRICKS AND TILE
STONES, SAND
CEMENT
MORTAR
CONCRETE
TIMBER
METALS AND OTHER ENGINEERING MATERIALS
PAINTS AND VARNISHES
BUILDING CONSTRUCTION
CONSTRUCTION PLANNING AND STORAGE OF MATERIAL
FOUNDATION
BRICKS AND STONE MASONRY
DAMP PROOFING
LINTEL AND ARCHES
ROOFS AND ROOF COVERINGS
DOORS AND WINDOWS
SCAFFOLDING
STAIR AND STAIRCASES
FLOORING
WALL FINISH

2. STRENGTH OF MATERIALS & THEORY OF STRUCTURE:

STRENGTH OF MATERIALS
BENDING MOMENT & SHEAR FORCE IN BEAMS
BENDING STRESS IN BEAMS
SHEARING STRESSES IN BEAMS
COLUMNS & STRUTS
COMBINED BENDING & DIRECT STRESS
COMPOUND & COMPLEX STRESS
STRAIN ENERGY & IMPACT LOADING

THEORY OF STRUCTURES

DEFINITIONS & GENERAL PRINCIPLES

PRIMARY STRESS ANALYSIS FOR STATICALLY DETERMINATE PIN JOINTED STRUCTURES
FIXED & CONTINUOUS BEAMS, PROPPED CANTILEVER
MOMENT DISTRIBUTION METHOD
RETAINING WALLS (EARTH RETAINING STRUCTURES)

3. FOUNDATION ENGINEERING:

GENERAL CONSIDERATIONS FOR DESIGN OF FOUNDATIONS
TYPES OF FOUNDATION
BEARING CAPACITY OF SOILS
SETTLEMENT OF FOUNDATION
PILE FOUNDATION
SOIL STABILISATION
SOIL EXPLORATION
STRESS DISTRIBUTION IN SOILS
EARTH PRESSURE

4. CONCRETE TECHNOLOGY:

MATERIALS FOR CEMENT CONCRETE
PREPARATION OF CONCRETE
CONCRETE MIX DESIGN
QUALITY CONTROL
SPECIAL CONCRETE
DETERIORATION AND RESTORATION OF CONCRETE

5. QUANTITY SURVEYING

DEFINITION OF AN ESTIMATE AND TYPES
SYMMETRICAL & UNSYMMETRICAL BOUNDARY WALL (USING MODULAR & TRADITIONAL BRICKS)
CENTRE LINE, LONG WALL & SHORT WALL METHOD WITH EXAMPLE
DEFINITION OF FLOOR AREA, CARPET AREA, PLINTH AREA, FAR
ESTIMATE OF DIFFERENT ITEMS OF WORKS INVOLVED IN A SINGLE STOREY RESIDENTIAL BUILDING
ESTIMATE OF R.C.C. BEAMS, CHUJIA, LINTEL AND SLAB (ONE WAY & TWO WAY REINFORCEMENT) SHOWING BAR BENDING SCHEDULE)
CALCULATION OF QUANTITY OF MATERIALS OF DIFFERENT ITEMS OF WORKS
CALCULATION OF VOLUME OF EARTH WORK OF DIFFERENT WORKS
QUANTITY & COST ESTIMATE
CONTRACTS
PWD ACCOUNTS
ARBITRATION
VALUATION

**CIVIL ENGINEERING
PAPER – II**

**Total Marks – 200
Duration of Examination – 3 Hours**

1. HYDRAULICS

INTRODUCTION
FLUID STATIC
FLUID FLOW
FLUID MEASUREMENT
FLOW THROUGH PIPES
OPEN CHANNEL FLOW

2. IRRIGATION

HYDROLOGY
WATER REQUIREMENT OF CROPS
CANAL IRRIGATION
WELL IRRIGATION
CANAL HEAD WORKS
FLOOD CONTROL
WATER LOGGING
LAND RECLAMATION
MAJOR IRRIGATION PROJECTS IN INDIA

3. ENVIRONMENTAL ENGINEERING

AIR POLLUTION
AIR POLLUTION CONTROL MEASURES & EQUIPMENT
METHODS & APPROACH OF AIR POLLUTION CONTROL
DIFFERENT SOURCES OF WATER POLLUTION
WATER POLLUTION & ITS CONTROL
SOLID WASTE DISPOSAL

4. SURVEYING

LINEAR MEASUREMENTS
CHAIN SURVEYING
COMPASS SURVEYING
LEVELLING
CONTOURING
THEODOLITE SURVEYING
EARTH WORK CALCULATION
PLANE TABLE SURVEYING
COMPUTATION OF AREAS
COMPUTATION OF VOLUME

5. TRANSPORTATION ENGINEERING

PROJECTS & PROFILES
PERMANENT WAY
TRACK GEOMETRICS
POINTS & CROSSINGS

STATIONS & YARDS
PERMANENT WAY MAINTENANCE
ROAD DRAINAGE
TRAFFIC ENGINEERING
HIGHWAY MAINTENANCE

**MECHANICAL ENGINEERING
PAPER – I**

**Total Marks - 200
Duration of Examination – 3 Hours**

1. ENVIRONMENTAL ENGINEERING:

AIR POLLUTION
ANALYSIS OF AIR POLLUTANTS
AIR POLLUTION CONTROL MEASURES & EQUIPMENT
METHODS & APPROACH OF AIR POLLUTION CONTROL

WATER & ENVIRONMENT

WATER SOURCES
DIFFERENT SOURCES OF WATER POLLUTION
WATER POLLUTION & ITS CONTROL
NOISE & ENVIRONMENTAL MANAGEMENT SYSTEM
NOISE POLLUTION & CONTROL
ENVIRONMENTAL LEGISLATIONS, AUTHORITIES & SYSTEMS

2. MECHANICS OF MATERIALS

Stress and strain
Thin cylinder and spherical shells
Deflections of beams
Torsion of solid and hollow circular shafts
Springs
Riveted joints

3. MACHINE TOOL

GENERAL INTRODUCTION
METAL CUTTING
LATHE AND LATHE WORKS
DRILLING MACHINE

BORING MACHINE SHAPER & PLANNER

MILLING MACHINE
GRINDING MACHINE

4. FLUID MECHANICS

PHYSICAL PROPERTIES OF FLUIDS
FLUID STATICS
FLUID KINEMATICS
FLUID MEASUREMENTS

IMPACT OF JET
PUMPS
HYDRAULIC TURBINE

MECHANICAL ENGINEERING
PAPER – II

Total Marks – 200
Duration of Examination – 3 Hours

1. AUTOMOBILE ENGINEERING

CONSTRUCTIONAL FEATURES
FUEL SUPPLY SYSTEM
COOLING SYSTEM
LUBRICATION SYSTEM
INTAKE & EXHAUST SYSTEM
FUELS
COMBUSTION IN ENGINE
AUTOMOBILE EMISSION & ITS CONTROL
ELECTRICAL SYSTEM
CHASSIS & BODY
TRANSMISSION SYSTEM
GEAR BOX
PROPELLER SHAFT & FINAL DRIVE
SUSPENSION SYSTEM
STEERING SYSTEM
BRAKING SYSTEM
WHEEL & TYRE
GARAGE AND SERVICE STATION

2. NON CONVENTIONAL ENERGY SOURCES

SOLAR POWER PLANTS
SOLAR ENERGY
SOLAR RADIATION
WIND POWER PLANTS
WIND ENERGY
ENERGY FROM BIO-MASS

3. REFRIGERATION & AIR-CONDITIONING

AIR REFRIGERATION SYSTEM
VAPOUR COMPRESSION REFRIGERATION SYSTEM
VAPOUR ABSORPTION SYSTEM
REFRIGERANTS
REFRIGERATION COMPONENTS, CONTROL AND SAFETY DEVICES
APPLICATION OF REFRIGERATION

**ELECTRICAL ENGINEERING
PAPER – I**

**Total Marks - 200
Duration of Examination – 3 Hours**

1. POWER PLANT ENGINEERING

Conventional sources of Energy – Fossil fuels, Hydroelectric and nuclear.
Thermal Power Station:
Hydro-electric Power Stations:
Nuclear Power Plants:
Diesel Power Plant & Gas-turbine Plants:
Elementary idea about Major Electrical Equipments used in Power Stations:
Combined working of power plants
Control of Active and Re-active power-Load-frequency control
Performance of power stations and Economic considerations:

2. ELECTRICAL DESIGN & ESTIMATING

Design and Specification:
Design of an electrical installation of machines in a workshop (Maximum 4 machines) [out of 4 machines at least 1 no. should be of 1-phase]
I.E. rules related to Power Sub-circuit.
Design of Electrical Machine:

Design of a 3-phase transformer up to 200 KVA: -

Estimation of a small residential complex.
Estimation of lighting scheme of a large Auditorium and Public Health Centre,
Estimation of electrical installation of machines (not more than four) in a workshop
Estimation for giving 3 – phase O.H. service connections to a residential building.

3. ELECTRICAL MACHINES

GENERAL INTRODUCTION OF ROTATING MACHINE

D.C Machines:
D.C. Generator
D.C. Motors:
TRANSFORMERS
1-phase Transformers:
Principles of 1-phase Autotransformer
Three-phase transformer
Alternator
3-Phase Induction Motor
Synchronous Motor:

Fractional H.P. Motors:

4. TRANSMISSION & DISTRIBUTION POWER

Transmission System
Constructional Features of Transmission & Distribution Lines
Mechanical Features of Overhead lines
Spacing of conductors, length of span, Relevant I.E. Rules
Electrical features of Overhead lines
Power Factor Improvement
Using Static condenser and Synchronous condenser – related problems
Distribution System
Sub-stations
Extra High Voltage DC System of Transmission

ELECTRICAL ENGINEERING PAPER – II

**Total Marks - 200
Duration of Examination – 3 Hours**

1. BASIC ELECTRONICS

Passive & Active Circuit Elements
Familiarity with the following components: —
RESISTORS, FUSES, CAPACITORS, INDUCTOR,
Voltage source and current source
AC and DC signals, Transformer

RELAYS, SWITCHES, CABLES AND CONNECTORS
ZENER DIODE
BIPOLAR TRANSISTOR
FIELD EFFECT TRANSISTOR
UNI JUNCTION TRANSISTOR
THYRISTOR
OPTOELECTRONICS
INTEGRATED CIRCUITS

2. ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

Definition & brief explanations of:
Range, sensitivity, true & indicated value, Errors (including limiting errors),
Resolutions, Accuracy, Precision and instrument efficiency.
Classification of instruments:
Basic Requirements for measurements:
Different types of instruments:
voltmeter, ammeter, multimeter, energy-meter.

Multi-range ammeter and voltmeter
Methods of measuring diff. Electrical quantities:
1-phase Induction type energy meter.
Errors adjustments
Phantom loading
Testing of energy meters.
Classifications of resistances
Description of Meggar.
Measurement of capacitance:
Magnetic measurements:
Instrument Transformers:
CT
PT or VT
Diff. Types of faults

3. CIRCUIT THEORY

NETWORKS & A.C. FUNDAMENTALS

Single-phase A.C. Circuits:
R-L-C Series Circuit:
Parallel Circuit:

RESONANCE & SELECTIVITY

SERIES RESONANCE:
PARALLEL RESONANCE:

TRANSIENTS (FOR ELECTRICAL ENGINEERING ONLY)

Steady State & Transient Response.

POLYPHASE CIRCUITS:

COUPLED CIRCUITS:

LAPLACE TRANSFORMATIONS:

FILTERS:

LAPLACE TRANSFORMATIONS

4. ELECTRICAL MEASUREMENT & CONTROL

Measurement of Power/Energy & Industrial Metering:

Digital energy-meter

Operation & Utility of Tri-vector meter.

Digital frequency meter

(i) Mech. Resonance type (ii) Electrical resonance type Frequency meter

Power manager.

Synchroscope:

Phase-sequence meter

Digital multimeter

C.R.O.—block diagram representation & operation, applications

Use of dual trace oscilloscope.

Function generator—

Frequency Counter—

Elements of Servomechanism:

Stepper Motor—

Measurement of Non-electrical quantities:

Study of the following transducers:

Piezo-electric crystal.

Thermistor.

Strain gauge.

Proximity switch.
Thermocouple.
LVDT.
Tachogenerator(a.c.& d.c.)
Capacitive transducers—
Seismic transducers.

CONTROL SYSTEM:

Brief descriptions with physical example (alongwith schematic diagram) of:

On-off controller.
Proportional controller.
Proportional plus derivative controller.
P+I controller.
P + D + I controller.

5. ELECTRICAL INSTALLATION, MAINTENANCE AND TESTING

General guidelines for Installation:
Loading & unloading of heavy electrical m/c:
Electrical Installation requirements:
Earthing Installation:
General requirement of electric installation according to I.E. Rules:
Motor generator set for battery charging and to supply various loads.
Synchronization of two alternators.
Maintenance of electrical installations
Insulation:
Troubleshooting:
Repair & Maintenance with Maintenance Schedule of:
D.C. machine
Transformer
Induction motor
Switchgear & Substation:
Relays
Brief account of maintenance of contactors.
Storage Batteries-
OH lines and Cables:
Testing
Electric Safety Regulations:

(T.K.Bhowmik)
Deputy Secretary
Public Works Department
Govt. of Tripura.