

श्री कार्यरथी विभाग, भर्ना छनौट निर्देशनालय
जंगी अड्डा
प्रा.सु.यान्त्रिक मेकानिकल/यान्त्रिक सेल पद (खुला) को पेशा सम्बन्धि लिखित
परीक्षाको पाठ्यक्रम

समय:- ३ घण्टा

पुर्णाङ्क - १००
उतिर्णाङ्क - ४०

उद्देश्यहरु:

यो पाठ्यक्रम नेपाली सेनाको प्रा.सु.यान्त्रिक मेकानिकल/यान्त्रिक सेल पदको उम्मेदवार छनौट परीक्षाको लागि निर्धारण गरिएको हो । प्रा.सु. पदका उम्मेदवार छनौटको लिखित परीक्षामा सरिक हुने उम्मेदवारहरुको पेशा सम्बन्धी विषयलाई आधार मानि प्रश्नहरु सोधिनेछन् ।

(क) लिखित परीक्षाको माध्यम नेपाली/अंग्रेजी भाषा हुनेछ ।

(ख) निम्न पत्रहरुको पाठ्यक्रमको रुपरेखाअनुसार विषयवस्तु हुनेछ ।

(ग) लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई मात्र अर्को चरणको परीक्षामा सम्मिलित गराइने छ ।

(घ) प्रश्नपत्र निर्माण गर्दा सम्भव भएसम्म पाठ्यक्रममा समावेश भएका सबै विषय समेटिने छ ।

(ङ) नेपाली सेनाको तत्कालीन आवश्यकता तथा विविध परिस्थितिमा नेपाली सेनाको अनुकूल हुने गरी उल्लेखित विवरणहरुमा हेरफेर हुन सक्नेछ ।

(च) पाठ्यक्रम लागू मिति : २०६९/२/१६ गतेदेखि ।

प्रश्नको किसिम	प्रश्न संख्या र अंक	कैफियत
लामो उत्तर दिनु पर्ने प्रश्न	६ X ७ = ४२	
छोटो उत्तर दिनुपर्ने प्रश्न	७ X ४ = २८	
वस्तुगत	३० X १ = ३०	

1. Engineering Thermodynamics

5%

Basic Concepts: Systems, Zeroth law, First law. Steady flow energy equation. Heat and work transfer in flow and non-flow processes. Second law, Kelvin Planks and Clausius statements. Concept of entropy, Entropy changes in non-flow processes. Properties of gases and vapours, **Air standard cycles:** Otto, Diesel Dual combustion and Brayton cycles. Air standard efficiency. Reciprocating air compressors.

One dimensional fluid flow: Application of continuity and energy equations. Isentropic flow of ideal gases through nozzles. Simple jet propulsion system.

Refrigeration and Air-Conditioning: Principles of refrigeration, air-conditioning and heat pumps. Vapour compression and vapour absorption systems, co-efficient of performance. Properties of refrigerants.

Heat Transfer: Conduction: Fourier law of heat conduction for isotropic material. Thermal conductivity. Conduction in parallel, radial and composite wall,

Fundamentals of radiative heat transfer. **Fins:** rectangular and pin fins. Fin effectiveness and efficiency. Critical thickness of insulation.

Radiation: Physical mechanism of thermal radiation, laws of radiation, definition of black body emissive power, intensity of the radiation, emissivity, reflectivity, transmittivity, irradiation, radiosity. Radiation exchange between black bodies. Concept of Gray-Diffuse Isotropic (GDI) surface. Radiation exchange between GDI surfaces.

Convection: Introduction, Newton's law of cooling and significance of the heat transfer co-efficient. Momentum and energy equations in two dimensions, importance of non-dimensional quantities and their physical significance. Natural convection.

Overall heat transfer co-efficient.

Heat exchangers: Types of heat exchangers, parallel and counter flow types, Correction factors, fouling factor.

Combustion Analysis: Fuels, Air requirements, excess air, analysis of products of combustion. Analysis of fuels

2. Strength of Materials

5%

Internal forces, Stresses and strains, Elasticity, Hooke's law, Poisson's ratio, Elastic constants and their relationship. Stress-strain diagram for ductile materials.

Definition of creep, fatigue and stress relaxation.

Bending of Beams: Shear force and bending moment, diagrams for simply supported and cantilever beams. Pure bending. Bending stress in straight beams.

Torsion and Columns: General knowledge, Types of Columns

Stresses in thin walled pressure vessels. Combined bending and torsion.

Deflection of Beams: General concept, Strain energy in tension, compression, shear, bending and torsion.

3. Fluid Mechanics

5%

Introduction: Classification of fluids. Properties of fluids. Centre of pressure. Plane and curved surfaces. Buoyancy and stability of floating bodies.

Fluid Dynamics: Laws of kinematics of fluid flow. Continuity, momentum and energy equations. Bernoulli's equations and its applications. Pressure measurements, pitot static tube, venturimeter, and orifice plate. Applications of momentum equations.

Laminar and Turbulent Flows: Reynolds experiments. Flow relation between shear stress and pressure gradient. Flow between parallel plates. Characteristics of turbulent flow. Flow through pipes. Energy losses in pipes. Flow around immersed bodies.

Fluid Machinery: Principles of operations of centrifugal and axial pumps. Turbines. Principles and working of gear, vane and reciprocating pumps & turbines.

Hydraulic Valves, various symbols used in Hydraulics and hydraulic circuit diagram study

Principles of lubrication: Hydro-dynamic, hydro-static, elastohydrodynamic cases; Boundary film lubrication; Solid lubricants;

4. Theory of Machines

5%

Mechanisms and machines: Elements of kinematic chain, mobility and range of movements, miscellaneous mechanisms, Straight line generating mechanisms.

Velocity and acceleration- analysis of displacement, Synthesis of linkages, Kinematic analysis of machine

elements, Dimensional analysis for motion, Functioning and path generation.

Dynamics of rotary and reciprocating machines, Critical speeds, Turning moment diagrams and flywheels, Cam profile analysis, gear tooth profiles, static and dynamic force analysis of constrained kinematic systems, Precisional motions and gyroscopic stability.

Design of Machine Elements:

General considerations and procedure of machine design, factor of safety, stress and deflection analysis, engineering materials and applications, fits and tolerances, design of fasteners and fastenings - pin, cotter, knuckle, screw, rivets and welded joints.

Design of shafts and couplings, common power and force transmitting power screws, belt drives and springs.

Design of Mechanical Systems:

Endurance limit, Design of shafts, clutches and brakes - calculation of heat generation and heat dissipation

Gears: Gear tooth geometry, tooth systems, gear trains, gear box design, design of helical, bevel and worm gears from strength and wear considerations; Flywheel design;

Bearings and lubrication: selection procedure of antifriction bearings, journal bearings, hydrodynamic theory, design factors, the relation of the variables, heat balance, hydrostatic bearings. Concept of concurrent and simultaneous engineering. Example problems in design of mechanical systems.

5. Automotive Petrol Engines

10%

Engine Construction and Operation: Constructional details of 4-stroke petrol engine. Working principle, Otto cycle, actual indicator diagram.

Two stroke engine construction and operation. Comparison of four stroke and two-stroke engine operation. Firing order and its significance.

SI Engine Fuel System: Carburetor working principle. Requirements of an automotive carburetor; Starting, idling, acceleration and normal circuits of carburetors, compensation, Maximum power devices, constant choke and constant vacuum carburetors. Fuel feed systems, Mechanical and electrical pumps. Petrol injection.

Cooling and Lubrication System: Need for cooling system. Types of cooling system, Liquid cooled system, Thermosyphon system, Pressure cooling system. Lubrication system, Mist lubrication system, Wet sump and dry sump lubrication. Properties of lubricants. Properties of coolants.

Combustion and Combustion Chambers: Combustion in SI engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, knocks. Effect of engine variables and knock. Octane number, Combustion chambers, Different types, Factor controlling combustion chamber design.

Two Stroke Engines: Types of two strokes engines, Terminologies and definitions, Theoretical scavenging methods. Scavenging pumps. Types of scavenging.

6. Automotive Diesel Engines

10%

Engine construction and operation: Two stroke and four stroke diesel engines. Diesel cycle. Fuel-air and actual cycle analysis. Diesel fuel, Ignition quality. Cetane number.

Fuel Injection System: Requirements, Air and solid injection, function of components, Pressure waves, Injection lag, Unit injector, Mechanical and Pneumatic governors. Fuel injector-types of injection nozzle, Spray characteristics, injection timing, pump calibration.

Combustion Chambers: Importance of air motion-swirl, squish and turbulence-swirl ratio. Fuel air mixing –stages of combustion, delay period, factors affecting delay period. Knock in CI engines comparison of knock in CI & SI engines. Cetane number. Direct and indirect injection. Combustion Chambers-Air cell chamber, combustion chamber design objectives. Different types of combustion chamber.

Supercharging and Turbocharging: Necessity and limitation, Charge cooling, Types of supercharging and turbocharging, relative merits, matching of turbocharger.

Diesel Engine Testing and Performance: Automotive and stationary diesel engine testing and related standards. Engine power and efficiencies. Performance characteristics. Variables affecting engine performance. Methods to improve engine performance. Heat balance.

7. Materials Science and Technology

5%

Deformation mechanism.

Strengthening material: Strain hardening, alloying, precipitation, dispersion, fibre and texture strengthening. Iron carbon diagram.

Fracture, Fatigue and Creep: Fracture, classification and types, notch effects, stress concentration, concept of fracture toughness. Ductile brittle transition. Fatigue Mechanism of crack initiation and growth, factors affecting fatigue creep, creep curve and creep mechanism, metallurgical variables of creep.

Materials: Castability, machinability, formability and weldability of engineering materials such as steel, cast iron, alloy steels, brass, bronze and aluminum alloys.

Composite materials: fabrication techniques, materials for high temperature.

Selection of materials: Criteria of selecting materials for automotive components viz Cylinder block, Cylinder head, Piston, Piston ring, Gudgeon pin, Connecting rod, Crank shaft, Crank case, Cam, Cam shaft, Engine valve, Gear wheel, Clutch plate, Axle bearings, Chassis, Spring, body panel radiator, brake lining etc. Application of non-metallic materials such as composite, ceramic and polymers in automobile.

Heat Treatment and Surface Treatment: Heat treatment of steel. Annealing –types, normalising, hardening and tempering with specific relevance to automotive components, surface hardening techniques, induction flame and chemical hardening. Coating and corrosion resistance.

Electroplating, phosphating, anodizing, hot dipping, thermal spraying, hard-facing and thin film coatings.

8. Power Units and Transmission

7%

Requirement of transmission system.

Different types of clutch: Principle, construction, torque capacity and design aspects. Determination of gear ratios for vehicles. Performance characteristic in different speeds.

Hydrodynamic Drive: Fluid coupling: Principle of operation. Constructional details, torque capacity. performance characteristics, reduction of drag torques.

Torque Converter: Principle of operation, constructional details, performance characteristics, converter coupling, multistage torque converters

Transmission: various types of gear box, Electro-magnetic transmission, Automatic overdrive, Hydraulic control system for automatic transmission.

Hydrostatic Drive and Electric Drive:

Hydrostatic drive: Various types of hydrostatic drive systems-Principles of hydrostatic drive system, Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, Construction and working of typical Janny hydrostatic drive.

Electric drive: Principles of early and modified Ward Leonard Control system, advantages & limitations. performance characteristics.

Automatic Transmission Applications

9. Automotive Chassis

10%

Types of chassis with reference to power plant locations and drive. Vehicle frames. Various types of frames. Constructional details. Materials. Loads acting on vehicle frame. Front axle and Steering System: Types of front axle. Constructional details. Materials.

Front wheel geometry viz. Castor, Camber, King pin inclination, Toe-in. Conditions for true rolling motion of wheels during steering. Steering geometry. Constructional details of steering linkages. Different types of steering gear boxes. Steering linkages and layouts. Power and Power assisted steering.

Drive Line: Effect of driving thrust and torque reactions. Propeller shaft. Universal joints. Constants velocity universal joints. Front wheel drive. Final Drive Differential: Different types of final drive. Worm and worm wheel, Straight bevel gear, Spiral bevel gear and hypoid gear final drives. Double reduction and twin speed final drives.

Differential principles. Construction details of differential unit. Non-slip differential. Differential locks.

Differential housings. Rear Axles: Construction of rear axles. Types of loads acting on rear axles.

Full floating. Three quarter floating and semi floating rear axles. Rear axle housing. Construction of different types of axle housings. Multi axles vehicles. Construction details of multi drive axle vehicles.

Suspension System: Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs. Independent & Dependent suspension, Shock absorbers.

Braking System: Classification of brakes, drum brake & disc brakes. Constructional details-Theory of braking. Mechanical hydraulic and Pneumatic brakes. Servo brake. Power and power assisted brakes-different types of retarders like eddy current and hydraulic retarder.

10. Automotive Electrical Systems and Electronics

10%

Batteries: Principles and construction of lead-acid battery & alkaline battery. Characteristics of battery, rating capacity and efficiency of batteries.

Starting System: Condition at starting. Principle & construction of starter motor. Working of different starter drive units, care and maintenance of starter motor. Starter Switches.

Charging System: Generation of direct current. Shunt generator characteristics. Armature reaction.

Third brush regulation. Cut-out. Voltage & current regulators. Compensated voltage regulator alternators principle & constructional aspects and bridge benefits.

Ignition Systems : Types, Construction & working of battery coil and magneto ignition systems.

Relative merits, Centrifugal and vacuum advance mechanisms, types and construction of spark plugs, electronic ignition systems.

Lighting System & Accessories: Insulated & earth return systems. Positive & negative earth systems.

Details of head light & side light. Headlight dazzling & preventive methods. Electrical fuel pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, Automotive Electronics: Current trends in modern automobiles, Open and close loop systems-Components for electronic engine management. Electronic management of chassis system. Vehicle motion control.

Sensors and Actuators: Basic sensor arrangement, Types of sensors , Solenoids, stepper motors, and relays.

Electronic Fuel Injection and Ignition Systems: Introduction, feedback carburetor systems.

Throttle body injection and multi port or point fuel injection., fuel injection systems, Injection system controls.

Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control. Distributor less

ignition-Integrated engine control systems, Exhaust emission control engineering. Electronic dashboard instruments-Onboard diagnosis system, security and warning system.

11. Heavy construction equipment

10%

General idea about dozer, loader, grader, excavator, roller, crane, fork lift, trailer, scrapper, Classification and Requirements of these Vehicles: Power plants, chassis and transmission layout, Principles of operation

Hydraulic circuit of heavy equipment, power train, construction detail,

Fault findings and trouble shootings of general problems,

Repair & Maintenance of heavy construction equipment

Land clearing machines: Bush cutter, stumpers, Tree dozer, Rippers.

scrapers, drag and self powered types – Dump track and dumpers – Loaders, single bucket, multi bucket and rotary types- Power and capacity of earth moving machines.

Scrapers and Graders: Scrapers, elevating graders, self powered scrapers and graders.

Shovels and Ditchers : Power shovel, revolving and stripper shovels – drag lines – ditchers – Capacity of shovels.

12. Automotive Pollution and Control

3%

Introduction: Pollutants-sources-formation-effects-transient operational effects on pollution.

Combustion and Pollutant Formation: Chemistry of SI engine Combustion, HC and CO formation in 4 stroke and 2 stroke SI engines, NO formation in SI Engines, Effect of operating variables on emission formation.

CI engine Combustion and Emissions: Basic of diesel combustion-Smoke emission in diesel engines-Particulate emission in diesel engines. Color and aldehyde emissions from diesel engines, Effect of operating variables on emission formation.

Control Techniques for SI and CI: Design changes, optimization of operating factors, exhaust gas re-circulation, fumigation, air injector PCV system-Exhaust treatment in SI engines-Thermal reactors-Catalytic converters, Catalysts, Use of unleaded petrol. Test Procedure & Instrumentation for Emission Measurement and Emission Standards: Test procedures-NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Smoke meters, Emission standards.

13. Quality Control and Reliability Engineering

2%

Quality Concepts: Quality-Factors influencing quality, quality costs, economics of quality, Bureau of Various standards, ISO and its implication.

Statistical Process Control, Acceptance Sampling, Life Testing-Reliability-Systems Approach, Quality and Reliability

14. Vehicle Dynamics

3%

Introduction: Fundamentals of vibration, Mechanical vibrating systems,

Model of an automobile-Single, two, multi degrees of freedom systems-Free, forced and damped vibration. Magnification factor-Transmissibility, Vibration absorber.

Suspension and Tyres: Requirements. Spring mass frequency. Wheel hop, wheel wobble, wheel shimmy. Choice of suspension spring rate. Calculation of effective spring rate.

Vehicle suspension in force and apt directions. Ride characteristics of tyres, behaviour while cornering, power consumed by tyre, effect of driving and braking torque-Gough's tyre characteristics.

Vehicle Handling: Oversteer, under steer, steady state concerning. Effect of braking, driving torques on steering. Effect of camber, transient effects in concerning. Directional Stability of vehicles.

Stability of Vehicles: Load distribution. Calculation of tractive effort and reactions for different drives-Stability of a vehicle on a slope, on a curve and a banked road.

15. Vehicle Body Engineering

2%

Visibility: regulations, driver's visibility, test for visibility, Methods of improving visibility and space in cars.

Safety: safety design, safety equipments for car. Car body construction. Vehicle Aerodynamics: Objectives, Vehicle drag and types, various types of forces and moments, Effects of forces and moments, side wind effects on forces and moments, various body optimization techniques for minimum drag.

Wind tunnel testing: Flow visualization techniques, scale model testing. Component balance to measure forces and moments.

Floor height, engine location, entrance and exit location, seating dimensions.

Constructional details: Frame construction, Double skin construction-Types of metal section used-Regulations-Conventional and integral type construction.

Types of body, Dimensions of driver's seat in relation to controls, driver's cabin design.

Body Materials

16. Modern Vehicle Technology

3%

Nano technology in vehicle, Trends in Automotive Power Plants, Hybrid Vehicles,

Suspension Brakes and Safety: Air suspension-Closed loop suspension-antiskid braking system, Retarders, Regenerative braking safety cageair bags-crash resistance – passenger comfort.

Noise & Pollution: Reduction of noise – Internal & external pollution control through alternate fuels/ power plants-Catalytic converters and filters for particular emission.

Vehicle Operation and Control: Computer Control for pollution and noise control and for fuel economy-Transducers and operation of the vehicle like optimum speed and direction. Vehicle

Automated Tracks: Preparation and maintenance of proper road network-National highway network with automated roads and vehicles-Satellite control of vehicle operation for safe and fast travel.

17. Alternate Fuels and Energy Systems

2%

Introduction: Estimation of petroleum reserve-Need for alternate fuel-Availability and properties of alternate fuels-general use of alcohols- LPG-Hydrogen-Ammonia, CNG, and LNG-Vegetable oils and Biogas-Merits and demerits of various alternate fuels.

Alcohols: Properties as engine fuels, alcohols and gasoline blends-Combustion characteristics in engines-emission characteristics.

Natural Gas, LPG, Hydrogen and Biogas: Availability of CNG, properties modification required to use in engines-performance and emission characteristics of CNG using LPG in SI & CI engines.

Performance and emission for LPG-Hydrogen-Storage and handling, performance and safety aspects.

Vegetable Oils: Various vegetable oils for engines Esterification-Performance in engines-Performance and emission characteristics.

Electrical and Solar Powered Vehicles: Layout of an electric vehicle-Advantage and limitations-Specifications-System component, Electronic control system-High energy and power density batteries-Hybrid vehicle-Solar powered vehicles

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श्री कार्यरथी विभाग, भर्ना छनौट निर्देशनालय
जंगी अड्डा

प्रा.सु.यान्त्रिक मेकानिकल/यान्त्रिक सेल पदको प्रयोगात्मक परीक्षा पाठ्यक्रम

१. समय : ४५ मिनेट
२. प्रश्नसंख्या : ६ वटा (सबै अनिवार्य)
३. पूर्णाङ्क : ५०
४. उत्तिर्णाङ्क : २५
५. प्रश्नको निर्माण, प्रश्नभार (weightage) र समयको विवरण:

S.N.	Topic	Marks	Time -Minutes
1.	Parts Identification and location knowledge	5	5
2.	System verification	10	10
3.	Use of Various Measuring Instruments	10	10
4.	Assembling/Disassembling procedure and skill test	15	10
5.	Skill in using basic tools	5	5
6.	Use of machines and related equipment	5	5
	TOTAL	50	45

१. Parts Identification and location knowledge:

परीक्षार्थीले layout गरी राखिएका विभिन्न Auto Parts को Technical नाम लेख्नु पर्ने हुन्छ र दिइएको Parts कहा कहा प्रयोग हुन्छ भन्ने समेत खूलाउनु पर्ने छ । यसमा ५ प्रकारका सामानहरु देखाइनेछ र प्रत्येक नाम र प्रयोग सहि भएमा १ अंक प्रदान गरिनेछ ।

२. System verification:

परीक्षार्थीले layout गरी राखिएका विभिन्न Automobile Systems हरु मध्ये कुनै एकको बारेमा उत्तर दिनुपर्ने हुन्छ र सो को बारे बयान गर्नुपर्ने हुन्छ । अंकभार १० रहने छ ।

३. Use of Various Measuring Instruments

परीक्षार्थीलाई विभिन्न प्रकारका Measuring Instrument दिइनेछ । उक्त measuring Instruments प्रयोग गरेर कुनै वस्तुको Density, Weight, Mass, Length वा सम्बन्धित ईकाइ पत्ता लगाउनु पर्ने हुन्छ । प्रति सहि answer को अंक २ प्रदान गरिनेछ ।

४. Assembling/ Disassembling

परीक्षार्थीलाई Automobile मा रहेको कुनै Partially Disassembled Component/System (eg. Gearbox,

Engine, Steering Gearbox, Alternator etc) लाई assemble गर्ने कार्य दिइने छ । Component कहांको हो पत्ता लगाएमा अंक ५ र Assemble गरेमा १० अंक प्रदान गरिने छ ।

५. Skill in using basic tools

परीक्षार्थीलाई workshop मा प्रयोग हुने कुनै ५ वटा tools प्रयोग गर्न लगाईने छ । प्रयोग सहि भएमा १ अंकको दरले marks प्रदान गरिनेछ ।

६. Use of machines and related equipment

परीक्षार्थीलाई shop मा प्रयोग हुने machine and equipment हरुको सम्बन्धमा Viva पश्न लिईनेछ, उक्त Viva मा ५ वटा प्रश्न सोधिनेछ । प्रत्येक सहि उत्तरको अंक १ प्रदान गरिनेछ ।

७. प्रयोगात्मक परीक्षामा परीक्षार्थीले कार्य सम्पादन गरेको सम्पूर्ण विवरणहरुका सम्भव भएसम्म Hard/Soft Copy प्रत्येक उम्मेदवारहरुको छुट्टाछुट्टै खाममा सिलबन्दि गरी भर्ना छनौट निर्देशनालयमा पठाउनु पर्नेछ ।

८. प्रयोगात्मक परीक्षाको अनुगमन श्री लोक सेवा आयोग वा श्री रक्षा मन्त्रालयका प्रतिनिधिबाट अनिवार्य रुपमा हुनेछ ।