

## नेपाली सेना

### प्रा.जम हेभि लाईट भेहिकल मेकानिक्स पदको लिखित परीक्षाको पाठ्यक्रम

(खुल्ला)

समय: ३ घण्टा

पुर्णाङ्क: १००

उत्तिर्णक: ४०

यो पाठ्यक्रम नेपाली सेनाको प्रा.जम. हेभि लाईट भेहिकल मेकानिक्स पदको उम्मेदवार छनौट परिक्षाको लागि निर्धारण गरिएको हो । प्रा.जम. हेभि लाईट भेहिकल मेकानिक्स पदको उम्मेदवार छनौट लिखित परिक्षामा सरिक हुने उम्मेदवारहरूको पेशा सम्बन्धी विषयलाई आधार मानी सोधिने छ ।

१. लिखित परिक्षाको माध्यम नेपाली/अंग्रेजी भाषा हुनेछ ।
२. निम्न पत्रहरूको पाठ्यक्रमको रूपरेखा अनुसार विषयवस्तु हुनेछ ।
३. लिखित परिक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र अर्को चरणको परिक्षामा सम्मिलित गराईनेछ ।
४. प्रश्नपत्र निर्माण गर्दा पाठ्यक्रममा समावेश भएका सबै विषयहरू समेटिने छ ।
५. नेपाली सेनाको तत्कालिन आवश्यकता तथा विविध परिस्थितीमा नेपाली सेना अनुकूल हुने गरी उल्लेखित विवरणहरूमा हेरफेर हुन सक्नेछ ।
६. पाठ्यक्रम लागु मिति २०७१/०९/२८ गते ।

प्रश्नको किसिम	प्रश्नको संख्या र अंक	कैफियत
बस्तुगत	३०X१=३०	
छोटो उत्तर दिनु पर्ने पश्न	१५X२=३०	
लामो उत्तर	८X५=४०	
जम्मा	१००	

## 1. Introduction to Engine: 10%

Description of internal combustion engines, Classification of IC engines, Principle & working of 2&4-stroke diesel engine (Compression ignition Engine (C.I)), Principle of Spark Ignition Engine(SI), differentiate between 2-stroke and 4 stroke, C.I engine and S.I Engine, Direct injection and Indirect injection, Technical terms used in engine, Engine specification. Study of various gauges/instrument on a dash board of a vehicle- Speedometer, Tachometer, Odometer and Fuel gauge, and Indicators such as gearshift position, Seat belt warning light, Parking-brake-engagement warning light and an Engine-malfunction light

## 2. Diesel Engine Components: 25%

Description and Constructional feature of Cylinder head, Importance of Cylinder head design, Type of Diesel combustion chambers, Effect on size of Intake & exhaust passages, Head gaskets

**2.1 Valves & Valve Trains:** Description and Function of Engine Valves, Different Types, Materials, Type of valve operating mechanism, Importance of Valve seats, and Valve seats inserts in cylinder heads, importance of Valve rotation, Valve stem oil seals, size of Intake valves, Valve trains, Valve-timing diagram, concept of Variable valve timing. Description of Camshafts & drives, Description of Overhead camshaft, Timing belts & chains, Timing belts & tensioners

**2.2 Piston:** Description & functions of different types of pistons, piston rings and piston pins and materials. Used recommended clearances for the rings and its necessity precautions while fitting rings, common troubles and remedy. Compression ratio

**2.3 Connecting Rod:** Description & function of connecting rod, importance of big- end split obliquely, Materials used for connecting rods big end & main bearings. Shells piston pins and locking methods of piston pins

**2.4 Crank Shaft:** Description and function of Crank shaft, camshaft, Engine bearings-classification and location – materials used & composition of bearing materials- Shell bearing and their advantages- special bearings material for diesel engine application bearing failure & its causes-care & maintenance. Crank-shaft balancing, Firing order of the engine

**2.5 Fly Wheel:** Description and function of the fly wheel and vibration damper. Crank case & oil pump, gears timing mark, Chain sprockets, chain tensioner etc. Function of clutch & coupling units attached to flywheel

**2.6 Cylinder Block:** Description of Cylinder block, Cylinder block construction, and Different type of Cylinder sleeves (liner)

**2.7 Cooling System:** Need for Cooling systems, Heat transfer method, Boiling point & pressure, Centrifugal force, Vehicle coolant properties and recommended change of interval, Different type of cooling systems, Basic cooling system components- Radiator, Coolant hoses, Water pump, Cooling system thermostat, Cooling fans, Temperature indicators, Radiator pressure cap, Recovery system, Thermo-switch

**2.8 Lubrication System:** Need for lubrication system, Functions of oil, Viscosity and its grade as per SAE, Oil additives, Synthetic oils, The lubrication system, Splash system, Pressure system, Corrosion/noise reduction in the lubrication system. Lubrication system components - Description and function of Sump, Oil collection pan, Oil tank, Pickup tube, different type of Oil pump & Oil filters Oil pressure relief valve, Spurt holes & galleries, Oil indicators, Oil cooler

**2.9 Intake & Exhaust Systems:** Description of Diesel induction & Exhaust systems. Description & function of air compressor, exhauster, Super charger, Intercoolers, turbo charger, variable turbo charger mechanism

**2.9.1 Intake system components:** Description and function of Air cleaners, Different type air cleaner, Description of Intake manifolds and material

**2.9.2 Exhaust system components:** Description and function of Exhaust manifold, Exhaust pipe, Extractors, Mufflers- Reactive, absorptive, Combination., Catalytic converters, Flexible connections, Ceramic coatings, Back-pressure, Electronic mufflers

**2.10 Diesel Fuel Systems:** Description and function of Diesel fuel injection, fuel characteristics, concept of Quiet diesel technology & Clean diesel technology

**2.10.1 Diesel fuel system components:** Description and function of Diesel tanks & lines, Diesel fuel filters, water separator, Lift pump, Plunger pump, Priming pump, Inline injection pump, Distributor-type injection pump, Diesel injectors, Glow plugs, Cummins & Detroit Diesel injection

**2.10.2 Electronic Diesel control:** Electronic Diesel control systems, Common Rail Diesel Injection (CRDI) system, Hydraulically actuated electronically controlled unit injector (HEUI) diesel injection system. Sensors, actuators and ECU (Electronic Control Unit) used in Diesel Engines

**2.11 Emission Control: Vehicle emissions standards:** Euro and Bharat II, III, IV, V Sources of emission, Combustion, Combustion chamber design

**2.11.1 Types of emissions:** Characteristics and Effect of Hydrocarbons, Hydrocarbons in exhaust gases, Oxides of nitrogen, Particulates, Carbon monoxide, Carbon dioxide, Sulfur content in fuels Description of Evaporation emission control, Catalytic conversion, Closed loop, Crankcase emission control, Exhaust gas recirculation (EGR) valve, Controlling air-fuel ratios, Charcoal storage devices, Diesel particulate filter (DPF). Selective Catalytic Reduction (SCR), EGR VS SCR

**2.12 Charging Circuit:**

Description of charging circuit operation of alternators, regulator unit, ignition warning lamp- troubles and remedy in charging system. Description of starter motor circuit, Constructional details of starter motor solenoid switches, common troubles and remedy in starter circuit.

**2.13 Troubleshooting:** Causes and remedy for Engine Not starting – Mechanical & Electrical causes, High fuel consumption, Engine overheating, Low Power Generation, Excessive oil consumption, Low/High Engine Oil Pressure, Engine Noise.

### **3. Petrol Engine Basics: (25 Marks)**

**3.1 4-stroke spark-ignition engines:** Basic 4-stroke principles

**3.2 Spark-ignition engine components:** Basic engine components, Engine cams & camshaft, Engine power transfer, Scavenging, Counter weights, Piston components.

**3.3 Intake & exhaust systems:** Carbureted systems, Electronic fuel injection systems, Exhaust systems. Intake system components, Air cleaners, Carburetor air cleaners, EFI air cleaners, Intake manifolds, Intake air heating.

**3.4 Gasoline Fuel Systems:** Description of Gasoline fuel, Gasoline fuel characteristics, Controlling fuel burn, Stoichiometric ratio, Air density, Fuel supply system, Pressure & vacuum. Carburation, Carburetor systems, Metering jets, Accelerating, Carburetor barrels Mechanical fuel pumps, Electric fuel pumps, Tanks & lines, Fuel lines, Charcoal canister, Carburetor filters.

**3.5 Introduction to Electronic Fuel Injection (EFI) System:** Basic EFI principles, Air supply, Air volume, Multi-point injection systems (MPI/MPFI), Simultaneous injection, efficient combustion.

**3.5.1 EFI fuel supply system components :** Fuel pumps, Fuel filters, Tanks & lines, Fuel lines, Fuel rail, Fuel pressure regulator, Injectors, Tachometric relay, Thermostime switch, EFI sensors, Potentiometer, Auxiliary air valves, Idle speed control devices, Inertia sensors.

**3.5.2 EFI Engine Management:** EFI operation Modes of EFI, Electronic fuelinjection, Idle speed control systems, Feedback & looping, Cold start systems, Air measurement, Air-flow monitoring, Variable intake manifold system, Electrical functions, EFI wiring diagram

**3.6 Electronic Control Unit (ECU):** EFI system ECU, Electronic control unit settings, Engine speed limiting, Malfunction indicator lamp. Importance of Diagnostic Trouble Code (DTC) & its general format. Use of scan tool and retrievals of codes.

**3.7 EFI Sensors:** Intake Temperature sensor, Mass airflow sensor, Manifold absolute pressure sensor, Air vortex sensor, Fuel system sensor, Throttle position sensor, Exhaust gas oxygen sensor, Crank angle sensor, Hall effect voltage sensor

**3.8 Ignition Principles:** Faraday's laws, Primary and secondary winding of transformer, Ignition components, Spark plugs, Spark plug components, Vacuum & centrifugal units, Plug firing voltage

**3.9 Induction:** Inductive system operation, Induction wiring, Hall effect sensors, Hall effect operation, Optical type sensors Distributor less ignition systems, Insulated coils, Distributor less ignition system timing

**3.10 Charging System:** The purpose of Charging system, charging system components, charging system circuit, Alternator principles, Alternating current, Alternator components, Rectification, Phase winding connections, Rotor circuit, Voltage regulation, System operating voltage, High voltage charging systems, Rotor, Stator, Alternator end frames, Slip ring & brush assembly, Rectifier assembly, Alternator cooling fan

**3.11 Starting System:** Purpose of starting system, Starting system components, Starter motor principles, study of starter control circuits. Starter motor construction, Starter magnet types, Starter motoren gagement, Commutation, Switching, solenoid construction

**3.12 Lighting System:** Lamps/light bulbs, Lamp/light bulb information, LED lighting, Headlights-description of standard sealed beam, halogen sealed beam, composite and High intensity discharge (HID) headlights. Headlight & dimmer circuits, Park & tail light circuits, Brake light circuits, turn signal circuit, Cornering lights, Fog lights circuit, interior lights- courtesy, reading and instrument panel lights, Smart lighting , Reverse lights

**3.13 Heating Ventilation Air Conditioning (HVAC):** Vehicle heating, ventilation & cooling systems, Basic air-conditioning principles, Air-conditioning capacity, Air- conditioning refrigerant, Humidity Description and function of Fixed orifice, Control devices, Thermostatic expansion valve system, Thermal expansion valves, Air-conditioning compressors, Condensers & evaporators, Receiver drier, Lines & hoses, TX valve construction, Temperature monitoring thermostat, Refrigerants, Pressure switches, Heating elements Air-conditioning ECU, Ambient air temperature sensor, Servo motors, Electric servo motors, Automatic climate control sensors, Evaporator temperature sensor, Blower speed control, Ventilation systems

**3.14 Accessories:** Horn circuit, wiper circuit, power window components and circuit. Power door lock circuit, automatic door lock circuit, remote keyless entry system circuit, antitheft system, immobilizer system. Navigation system, Car radio and cassette player, car videos. Description and function of **Airbags**, Seatbelt, Vehicle safety systems, Crash sensors, Seat belt pre-tensioners, Tire pressure monitoring systems Integrated communications, Proximity sensors, Reflective displays, Global positioning satellites, Triangulation/trilateration, Telematics. Networking & multiplexing

#### **4. Heavy Vehicle Introduction: (25 Marks)**

Study of different major components & assemblies of heavy vehicle, and different make (indigenous). Name plate-constructional differences and their merits. Leading manufacturers in Heavy vehicle Industry

**4.1 Clutches & Manual Transmissions:** Clutch principles, Single-plate clutches, Multi-plate clutches, Dual mass flywheels, Operating mechanisms *Clutch components* Pressure plate, Driven/ center plate, Throw-out bearing

**4.1.2 Manual Transmissions:** Gear ratios, Compound gear trains, Gear selection, Bearings, Oil seals & gaskets, Brief about Automated Manual Transmission (AMT)

**4.1.3 Gearbox Layout & Operation:** Gearbox layouts, Transaxle designs, Gearbox operation, Baulk-ring synchromesh unit, Transaxle synchromesh unit. Gear shift mechanism

**4.1.4 Final Drive & Drive Shafts:** Basic layouts, Front-wheel drive layout, Rear-wheel drive layout, Four-wheel drive layout, All-wheel drive layout, 4WD v/s AWD, Front-wheel drive, Front-wheel drive shafts, Front-wheel final drives, Front-wheel differentials

**Rear-Wheel Drive:** Propeller shaft, Type of Universal joints, Type of Constant velocity Joints, Rear-wheel final drives, Salisbury axles, Rear-wheel drive differentials, Limited slip differentials

**4.1.5 Four-Wheel Drive:** Four-wheel drive shafts, Four-wheel final drive, Four-wheel drive transfer case, Freewheeling hubs, and Four-wheel drive differentials

**4.1.6 All-Wheel Drive:** four wheel final drives, All-wheel drive transfer case, Transfer case differential action

**4.2 Automatic Transmissions:** Torque converters, Torque converter principles, drive plate, Converter operation, Torque multiplication, Fluid flow, Heat exchanger, Lock-up converters, clutches

**4.2.1 Planetary Gearing:** Planetary gears, Simple planetary gear sets, Compound planetary gear sets, Automatic transmission brake bands, Multi-disc clutches

**4.2.2 Electronic Control Transmission:** Electronic control Unit, Fully hydraulically controlled transmission, Electronic shift programs, Manual selection. Layout & operation for P,R,N&D (1st & 2nd) Selector positions, Planetary gear set, High range power flow, Low range power flow Servos & clutches-Rear servo, Front servo, One way clutch, Multi-plate front clutch, Clutch pack, Rear clutch

**4.2.3 Hydraulic System & Controls:** Hydraulic system components, Spool valves, Regulating or flow control valves, Control valves, Orifices

**Valve Types & Functions:** Basic valve action, Regulator & control valves, Shift & governor valves

**4.2.4 Pressure regulation:** The primary regulating valve, Line pressure variation, Modulator valve pressure, The governor, Governor pressure, Kickdown pressure Flow control- Gear position 1, 1-2 shift valve, 2-3 shift valve assembly, The servo orifice control valve, 3-2 kick down

**4.2.5 Continuously variable transmission (C.V.T.):** Continuously variable transmission, Drive or reverse, The steel belt, Secondary pulley shaft

**4.3 Steering Systems:** Description and function of Steering systems, Principles of steering, Rack-and-pinion steering system, Recirculation ball & nut steering system, Four-wheel steering systems, collapsible steering system

**4.3.1 Steering boxes & columns:** Description and function of Steering columns, Rack- and-pinion gearbox, Helix, Variable ratio steering, Worm gearbox, Power Assisted steering, Steering process, Flow-control valve, Electric power assisted steering, Basic electric power steering operation

**4.3.2 Steering arms & components:** Forward control vehicle steering, Steering linkages, Joints, Bushes/bushings

**4.4 Wheel Alignment Fundamentals:** Basic principles of wheel alignment, wheel base, wheel track, king pin inclination, Caster, Camber, Scrub radius, Toe-in & toe out, Toe-out on turns, Turning radius, Thrust angle & centerlines

**4.5 Suspension Systems:** Principles of suspension, Suspension force, Unsprung weight, Wheel unit location

**4.5.1 Types of suspension:** Suspension systems, Solid axle, Dead axle, Description, function and advantages of non independent suspension Independent suspension, Rear independent suspension, Rear-wheel drive independent suspension, electronically controlled air suspension (ECAS), Adaptive air suspension operation

**4.5.2 Types of springs:** Description and function of Coil springs, Leaf springs, Torsion bars, Rubber springs

**4.5.3 Shock absorber types:** Description and function of Hydraulic shock absorbers, Gas-pressurized shock absorbers, Load-adjustable shock absorbers, Manual adjustable-rate shock absorbers, Electronic adjustable-rate shock absorbers, Automatic load-adjustable shock absorbers

**4.5.4 Front suspension types & components-** Mc person Strut suspension, Short/long arm suspension, Torsion bar suspension Rear suspension types & components-Rigid axle leaf spring suspension, Rigid axle coil spring suspension, Independent type suspension, Rigid non-drive suspension

**4.6. Wheels & Tyres:** Wheel types & sizes Wheels, Rim sizes & designations, Types of wheels

**Tyre types & characteristics:** Tyres, Radial ply tyres, Radial ply tyre sidewalls, Tyre pressure monitoring systems, Run flat tyres, Space-saver tyres, Tyre distortion, Center of gravity

**4.6.1 Tyre construction:** Tyre construction, Types of tyre construction, Tyre materials, Hysteresis, Tyre sizes & designations, Tyre information, Tyre tread designs, Tyre ratings for temperature & traction. Descriptions Tirewear Patterns and causes Nitrogen vs atmospheric air in tyres

**4.7 Braking Systems:** Principles of braking, Drum & disc brakes, Lever/mechanical advantage, Hydraulic pressure & force, Brake pad, Regenerative braking

**4.7.1 Brake type:** Principles, Air brakes, Exhaust brakes, Electric brakes, Parking brakes, Engine brakes, Regenerative braking

**4.7.2 Braking system components:** Park brake system, Brake pedal, Brake lines, Brake fluid, Bleeding, Master cylinder, Divided systems, Tandem master cylinder, Power booster or brake unit, Hydraulic brake booster, Electro hydraulic braking (EHB), Applying brakes, Brake force, Brake light switch

**4.7.3 Drum brakes & components:** Drum brake system, Drum brake operation, Brake linings & shoes, Back plate, Wheel cylinders

**4.7.4 Disc brakes & components:** Disc brake system, Disc brake operation, Disc brake rotors, Disc brake pads, Disc brake calipprs, Proportioning valves, Proportioning valve operation, Brake friction materials

**4.7.5 Dual Air Brake System and Dual Air Over Hydraulic Brake System**

**4.8 Antilock Braking System & Components-**ABS brake system, Antilock braking system operation, Principles of ABS braking, ABS master cylinder, Hydraulic control unit, Wheel speed sensors, ABS with EBD electronic control unit , The construction and operation of heavy vehicle Anti-Slip Regulation / Traction Control (ASR) system.

**5. Common Defects and Symptom Fault Correlation for Light Vehicle (7.5 Marks)**

Engine cranks but not starts (Hard Starting)  
Fuel pump not working  
Engine misfire at high speed  
Continuous blinking of MIL  
Noisy suspension  
Vehicle pulls to one side in normal drive  
Hard steering  
Incorrect idle RPM  
Engine not accelerating  
Steering wobbling

**6. Common Defects and Symptom Fault Correlation for Heavy Vehicle (7.5 Marks)**

Engine does not start  
Air pressure leakage  
Clutch not disengaging  
Brake air pressure leaking  
Unequal air pressure rising for both air tanks  
Brake pulling to our side  
Gears 1,3and 5 series gear not engaging  
Cabins not tipping/ tilting  
Hard steering



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(खुल्ला)

पुर्णाङ्क : ५०

उत्तीर्णाङ्क : २५

1. Fault Diagnosis of Automotive System in Light and Heavy Vehicle. **50 %**

Transmission System, Suspension System, Brake System and Lighting System

2. Identification of Automotive Spare Parts, Use and Handling of Workshop Tools and Measuring Instrument **50 %**

प्रा.जम हेभि लाईट भेहिकल मेकानिक्स पद लिखित परीक्षा

(खुल्ला)

नमुना प्रश्न पत्र

**Multiple Choice Question**

1. How many types of thermostat valve are used in automobile?
  - (a) One type
  - (b) Two type
  - (c) Three type
  - (d) Four type
2. Long spill is the movement of.
  - (a) FIP
  - (b) Injector
  - (c) FLP
  - (d) Plunger

**Short Question/Answer**

1. What are the advantages of MPFI system compared to carburetor fuel system?

**Long Question/Answer**

1. Explain how the computer controls the air/fuel ratio on MPFI system.

**Practical Exam Question**

**Fault finding**

- (a) Vehicle is not starting, self starter cranking and moves normally. What is the main cause?
- (b) Low fuel pressure, what is the main cause?
- (c) Engine Idling up, how to rectify?
- (d) Engine RPM high, what will you check?
- (e) Engine off in Idling condition, what will you check?
- (f) If MIL indicates defective O<sub>2</sub> Sensor then what is the main cause?
- (g) Why you check the IAC duty performance?