

**Detail Syllabus
For
Automobile Engineer, T/Lt**

Total Time: - 2 Hrs 30 Minutes.

Full Marks: - 100

Pass Marks: - 40

This Syllabus is prescribed for the recruitment purpose of the Automobile Engineer in Nepal Army. The candidates for the Automobile Engineer for the post of Technical Lieutenant will have to appear for the written test based on the following syllabus on the professional subject matters. The following factors will be considered in the examination.

1. Medium for the written test shall be English.
2. Candidates who secured the pass marks in the written examination will only be considered for the next phase of the test.
3. All the sections mentioned in the detail syllabus will be included in the test paper.
4. Examination system, the details, the format, the timing and the syllabus for the test paper may change as per the requirements and the conditions suitable to the situation favorable to the Nepal Army.
5. The sample questionnaires given at the end of the syllabus are for the reference purpose only. They can only be referred to understand the examination system and the details of the actual test.
6. Effective date of syllabus : 2070/ 04 / 10

Examination System	Details	No. Of Question x Marks	Time
Subjective Questions	Short Question	6 x 5 = 30	2 Hrs . 30 Mins
	Long Question	2 x 10 = 20	
Objective Questions (MCQs)	Multiple Choice	50 x 1 = 50	

Automobile Engineering

Block Syllabus

Section 1: Basic Engineering

(5%)

Engineering Mathematics: Linear Algebra and Matrices, Vector Algebra and Calculus, Differential Equations, Integral Equations, Calculus of Variations Approximation, Engineering Statistics, Numerical Methods, **Engineering Drawing:** Basic knowledge of Engineering drawing, Machine Drawing and symbols used in drawing, Assembly Drawings, AutoCAD **Concept of Electrical Engineering:** Fundamentals of Electric Circuits, Resistive and AC Network Analysis, AC Power, Frequency Response, Filters, Operational Amplifiers, Measurements and Instrumentation, Electromechanical Systems, Transformer, Principles of Electromechanical Energy Conversion DC Motors, DC Generators, Control of DC Machines in the steady state, Induction Machines, Synchronous Machines, General Aspects of Modeling and Steady State performance of DC machines. **Concept of Engineering Materials:** Metals, Polymers, Adhesives, Wood, Composites, Ceramics, Carbon, Glass and their properties, **Workshop Technology:** Bench Tools, Measuring Gauges and Basic Hand Operations, Power Tools, Drill And Drilling Processes, Machine Tools, Sheet Metal Work, Metal Joining, Heat Treating Methods

Section 2: Engineering Thermodynamics, Heat & Mass Transfer

(5%)

Fundamentals of thermodynamics, Combustion, Vapor and Gas Power Cycles, Concept of Heat Transfer: Conduction, Convection and Radiation, Phase Change, Heat Exchangers, Temperature and Heat Transfer Measurements, Mass Transfer, Applications, Heat Engines: Steam Power Plant, Gas Turbines, Internal Combustion Engines, Hydraulic Turbines

Section 3: Fluid Mechanics

(5%)

Fluid Statics, Equations of Motion and Potential Flow, Similitude; Dimensional Analysis, Hydraulics of Pipe Systems, Open Channel Flow, External Incompressible Flow, Compressible Flow, Multiphase Flow, Non-Newtonian Flow, Tribology, Lubrication, and Bearing Design, Pumps and Fans, Liquid Atomization and Spraying, Flow Measurement

Section 4: Mechanics of Solids

(3%)

Introduction, Statics, Dynamics, Vibrations, Structural Integrity and Durability, Comprehensive Example of Using Mechanics of Solids Methods

Section 5: Air-Conditioning and Refrigeration

(4%)

Introduction, Psychrometrics, Air Conditioning Processes and Cycles, Refrigerants and Refrigeration Cycles, Outdoor Design Conditions and Indoor Design Criteria, Load Calculations, Refrigeration Components and Evaporative Coolers, Air Conditioning Systems used in Automobiles

Section 6: Engineering Design and Manufacturing

(5%)

Engineering Design: Introduction, Elements of the Design Process, Concept of Domains, The Axiomatic Approach to Design, Algorithmic Approaches to Design, Strategies for Product Design, 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 factor Computer-Based Tools for Design Optimization, Computer-Aided Design (CAD), Manufacturing: Unit Manufacturing and Assembly Processes, Essential Elements in Manufacturing Processes and Equipment, Modern Design and Analysis Tools for Manufacturing, Computer Aided Manufacturing (CAM), Control Systems: Human – Machine Interaction, The need for Mechanical Systems Control, Control System Analysis, Control System Design and Application,

Section 7: Alternative Energy and Fuel Systems

(4%)

Introduction, Types of Derived Energy, Traditional Energy: Fossil Fuels, Alternative Energy: Biomass Energy, Nuclear, Solar Energy, Wind Energy, and Geothermal Energy, 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, Hydrogen Powered vehicles

Section 8: Automotive Engines Systems

(24%)

1. Engine Construction and Operation:

(3%)

Four stroke SI and CI engines, Working principle, function, materials, constructional details of engine components, Valve timing diagram, Firing order and its significance, relative merits and demerits of SI and CI engines, Two stroke engine construction and operation, Comparison of four-stroke and two-stroke engine operation

2. Fuels and Combustion

(6%)

Combustion equation, conversion of gravimetric to volumetric analysis, Determination of theoretical minimum quantity of air for complete combustion, Determination of air fuel ratio for a given fuel, Properties and rating of fuels (petrol and diesel), chemical energy of fuels, reaction equation, properties of air/fuel mixture, combustion temperature, combustion chart. **Combustion in SI Engines:** Combustion in premixed and diffusion flames, Combustion process, Stages of combustion, Flame propagation, Flame velocity and area of flame front, Rate of pressure rise, Cycle to cycle variation, Abnormal combustion, Theories of detonation, Effect of engine operating variables on combustion. Combustion chambers types, factors and design, **Combustion in CI Engines:** Importance of air motion; swirl, squish and turbulence, Swirl ratio, Fuel air mixing, Stages of combustion, Delay period, Factors affecting delay period, Knock, methods of controlling knock, Combustion chamber design, Induction swirl, turbulent combustion chambers.

3. Fuel Injection System

(9%)

Intake and Exhaust: Intake system components, Discharge coefficient, Pressure drop, Air filter, intake manifold, Connecting Pipe, Exhaust system components, Exhaust manifold and

exhaust pipe, Spark arresters, Exhaust mufflers, Types, operation, **Carburetion and Gasoline Injection:** Properties of air-fuel mixtures, Mixture requirements for steady state and transient operation, Mixture formation studies of volatile fuels, design of elementary carburetor Chokes, Effects of altitude on carburetion, Carburetor for 2-stroke and 4-stroke engines, carburetor systems for emission control. Petrol injection, Open loop and closed loop systems, mono point, multi point and direct injection systems, Principles and Features, Bosch injection systems, **Diesel Injection:** Air and solid injection, Function of components, Jerk and distributor type pumps. Pressure waves, Injection lag, Unit injector, Mechanical and pneumatic governors, Fuel injector, Types of injection nozzle, Nozzle tests, Spray characteristics, Injection timing, Factors influencing fuel spray atomization, penetration and dispersion of diesel, pump calibration.

4. **Engine Performance:** (6%)

Performance parameters, BP, FP, IP, specific fuel consumption, volumetric efficiency, thermal efficiency, mechanical efficiency, specific weight and heat balance, Testing of engines, different methods, Numerical problems, **Lubrication and Cooling:** Need for cooling system, Types of cooling system, Liquid cooled system, Thermo siphon system, Forced circulation system, pressure cooling system, properties of coolant, additives for coolants, Need for lubrication system, Mist lubrication system, wet sump any dry sump lubrication, Properties of lubricants, **Supercharging and Scavenging:** Effects on engine performance, Thermodynamics of supercharging and Turbocharging, Turbocharging methods, Engine exhaust manifold arrangements, Classification of scavenging systems

Section 9: Automotive Transmission (12%)

Clutch and Gear Box: Requirements of transmission system, Different types of clutches, principle, Construction, torque capacity and design aspects, Objective of the gearbox, Determination of gear ratios for vehicles, Performance characteristics at different speeds, Different types of gearboxes operation. Typical problems involving the above principles, Differentials, **Hydrodynamic Drive:** Fluid coupling, principle of operation, constructional details, torque capacity, performance characteristics, reduction of drag torque, Torque converters, Principle of operation, constructional details, performance characteristics, converter coupling, multistage and polyphase torque converters, **Automatic Transmission:** Ford-T model gearbox, Wilson gearbox, Automatic over drive, Hydraulic control system, Applications (Chevrolet Turbo glide transmission, Toyota “ECT-i” Power glides Transmission (Intelligent Electronic control system), Mercedes Benz Automatic transmission, Hydraulic actuation system), **Hydrostatic and Electric Drives:** Hydrostatic drive: principle, types, advantage and limitations, Comparison of hydrostatic drive with hydrodynamic drive. Construction and working of typical Janny hydrostatic drive, Electric drive, Principle of early and modified Ward Leonard Control system

Section 10: Automotive Chassis (15%)

1. **Automotive Suspension Systems:** MacPherson Struts, Ball Joints, and Torsion Bars; Electronic Ride Control and Air-Suspension Systems; Sonar Shock Absorbers and Active Suspension System; Inspecting suspension system components, MacPherson Strut Service, Suspension Service, Automotive **Steering Systems:** Recirculating Ball and Rack and Pinion Steering Gears; Electronic Power Steering and Four Wheel Steering; Wheel Alignment angles, Scrub Radius and Thrust angle, Steering Components Servicing, **Automotive Brakes:** Drum, Disc, Parking and Power Brakes; Brake System Valves and Master

- Cylinders; Antilock Braking and Traction Control Systems; Drum, Disc, Power and ABS Brake Diagnosis and Service, **Tires and Wheels:** Tubes, tires and speed ratings; Tire and Wheel Inspection, Balance, Service and Repair **(10%)**
2. **Car Body:** Types: Saloon, Convertibles, Limousine, Estate Van, racing and sports car Driver's visibility and tests for visibility, Minimum space requirements and methods of improving space in cars. Safety: safety design, safety equipment, Car body construction. **Vehicle Aerodynamics:** Vehicle drag and types, Effects of forces and moments: Side wind effects, techniques for minimum drag, Wind tunnel testing: Flow visualization techniques, Scale model testing, Component balance to measure forces and moments. **Bus Body:** Types: Mini bus, single and double Decker, Bus body layout: Floor height, Engine location, Entrance and exit location, Seating dimensions, Frame construction, Double skin construction **Commercial Vehicle:** Types: Flat platform, drop side, fixed side, tipper body, tanker body. LCV body types: pickup, van, Dimensions of driver's seat in relation to controls and steering angle, Driver cab design. **Body Materials, Trim and Mechanisms:** Aluminum alloy sheet, stainless steels, Metal Matrix Composites, Thermo plastics, Load bearing plastics, semi-rigid PUR foams and sandwich panel construction, Corrosion, Selection of paint and painting process. **(5%)**

Section 11: Automotive Electrical Systems

(10%)

Storage Battery, Charging System (Cutout, Voltage and current regulators, Bridge rectifiers), Starting System (Behavior of starter during starting, principle and construction of starter motor), Ignition System (Spark plugs ignition, Electronic ignition systems, programmed ignition, distributor less ignition), Lighting System and Accessories (Fusing of circuits, low and high voltage automotive cables, wiring diagram for typical automotive wiring system, head lamp, fog lamps, temperature gauge, oil pressure gauge, fuel gauge, speedometer, odometer)

Section 12: Miscellaneous Topics

(8%)

1. Patent Law and Miscellaneous Topics

(1%)

Patents and Other Intellectual Property, Product Liability and Safety, Bioengineering, Mechanical Engineering Codes and Standard, Optics, Water Desalination, Noise Control, Lighting Technology, New Product Development

2. Engineering Economics and Project Management

(2%)

Engineering Economic Decisions, Establishing Economic Equivalence, Measures of Project Worth, Cash Flow Projections, Sensitivity and Risk Analysis, Design Economics, Project Management

3. Transport Management and Automobile Industry

(3%)

a. Transport Management

(2%)

Supervising, Driver checklist, Lists for mechanic, Trip leasing, Vehicle operation, Vehicle Maintenance: Scheduled and unscheduled maintenance Planning, Work scheduling, Breakdown analysis, Control of repair backlogs, Vehicle Parts, Supply Management and Budget: Cost of inventory, Balancing inventory cost against downtime, Parts control, Bin tag systems, record keeping, Budget activity, Capital expenditures, Classification of vehicle expenses, Fleet management and data processing: Computer controlling of fleet activity, Scheduling and Fare Structure,

Route planning, Scheduling of transport vehicles, Preparation of timetable, Preparation of fare table.

- b. Automobile Industry** (1%)
History and development of the automobile industry, market trends, Auto industries, Role of the automobile industry in national growth

4. Automotive Pollution and Control (2%)

SI engine Combustion and Pollutant Formation, Effect of operating variables on emission formation, Smoke emission in diesel engines, Color and aldehyde emissions, Exhaust gas re-circulation, fumigation, Catalytic converters, Use of unleaded petrol, Test procedures-NDIR analyzer, Flame ionization detectors, Gas chromatograph, Smoke meters, Emission standards.

Sample questionnaires:

1. Long answer questions: Carry 10 Marks each.
- a. Mention the advantages and disadvantages of centrifugal compressors over reciprocating compressors (for refrigeration systems).
(Mention at least 10 points all together)
 - b. Name the various kinds of operations that can be performed in a milling machine.
(State any 10 types of operations).
2. Short answer questions: Carry 5 Marks each.
- a. Name any five types of tires. Explain about Run flat tires.
 - b. Define following terms:
 - a. Camber
 - b. Back Lash
 - c. Ductile material
 - d. Elastic material
 - e. autoCAD
 - c. Calculate the size / displacement of an eight - cylinder engine with the bore of 4 inches and a stroke of 3 inches.
3. Multiple choice questions: Carry 1 mark each.
- a. Multiple choice
 - 1. When the temperature of a solid metal increases,
 - a. Strength of the metal decreases but ductility increases
 - b. Both strength and ductility of the metal decrease
 - c. Both strength and ductility of the metal increase
 - d. Strength of the metal increases but ductility decreases

b. True false

2. Which one is true?

- a. More cylinders that an engine has, the bigger the vibration will be.
- b. No relation between cylinders of an engine and the vibration.
- c. More cylinders that an engine has, the lesser the vibration will be.
- d. All of them are false statement.

c. Fill in the blanks

3. Eight cylinder engine has.....degrees power overlap.

- a. 50 degrees
- b. 55 degrees
- c. 60 degrees
- d. 65 degrees