

Power Engineering (315371)

MSBTE Diploma · K-Scheme · Model Question Paper — Set C

Time: 3 Hours**Max. Marks: 70****Instructions:**

1. All questions are compulsory.
2. Answer each next main question on a new page.
3. Illustrate your answers with neat sketches wherever necessary.
4. Figures to the right indicate full marks.
5. Assume suitable data, if necessary.
6. Use of non-programmable electronic pocket calculator is permissible.
7. Use of steam tables, refrigerant tables and psychrometric chart is permitted.
8. Mobile phone, pager and any other electronic communication devices are not permissible in the examination hall.

Q.1 Attempt any FIVE of the following:**10**

- a) What is meant by one tonne of refrigeration? Show that $1 \text{ TR} \approx 3.5 \text{ kW}$.
- b) Define specific humidity and degree of saturation.
- c) Define brake specific fuel consumption (BSFC) and brake thermal efficiency.
- d) Define volumetric efficiency and mechanical efficiency of an air compressor.
- e) State the purpose of the Exhaust Gas Recirculation (EGR) system in an I.C. engine.
- f) List any four applications of vapour absorption refrigeration systems.
- g) List any four sources of energy wastage in a compressed air system.

Q.2 Attempt any THREE of the following:**12**

- a) List any eight desirable properties of an ideal refrigerant.
- b) Represent the following processes on a psychrometric chart: i) Sensible cooling ii) Humidification (latent heating) iii) Heating and dehumidification iv) Cooling and humidification.
- c) State the need of a heat balance sheet. Explain how the heat carried away by cooling water and by exhaust gases is measured during an engine trial.
- d) Represent the Bell-Coleman cycle on p–v and T–s diagrams, name the processes and state any two applications of air refrigeration.

Q.3 Attempt any THREE of the following:**12**

- a) Explain the working of a simple vapour compression refrigeration system with a neat sketch. Represent the cycle on a p–h diagram.
- b) Explain with a neat sketch the construction and working of a centrifugal compressor.

- c) Explain the method of determining the indicated power of a multi-cylinder engine without using an indicator. Why can this method not be used for a single-cylinder engine?
- d) Explain with a neat sketch the working of a simple aqua-ammonia vapour absorption refrigeration system.

Q.4 Attempt any THREE of the following:

12

- a) List any four factors each affecting the performance of: i) a compressed air system ii) a refrigeration and air-conditioning system.
- b) Explain with a neat sketch the working of a window air conditioner.
- c) Recommend any four energy saving opportunities for an office air-conditioning system, with reasons.
- d) State any four advantages of multistage compression. State the condition for minimum work in two-stage compression with perfect intercooling.
- e) A single-stage single-acting reciprocating compressor delivers 2.5 m^3 of free air per minute (measured at suction conditions 1.013 bar, 25°C) at a pressure of 8 bar. The clearance volume is 5 % of the swept volume and the law of compression and expansion is $pV^{1.3} = C$. Find (i) volumetric efficiency, (ii) indicated power, (iii) isothermal efficiency.

Q.5 Attempt any TWO of the following:

12

- a) A 2 TR R-134a vapour compression refrigerator works with an evaporator temperature of -10°C and a condenser temperature of 40°C . The vapour leaving the evaporator is superheated by 5°C and the liquid leaving the condenser is sub-cooled by 5°C . Compression is isentropic. Enthalpies (kJ/kg): vapour at compressor inlet = 396.9; vapour at compressor exit = 431.6; sub-cooled liquid at condenser exit = 249.0. For the simple saturated cycle between the same temperatures: dry saturated vapour at -10°C = 392.7, after isentropic compression = 426.5, saturated liquid at 40°C = 256.4. Find (i) refrigerating effect, (ii) mass flow rate, (iii) compressor power, (iv) COP, and (v) the percentage increase in COP due to superheating and sub-cooling.
- b) $150 \text{ m}^3/\text{min}$ of air at 38°C DBT and 20 % RH is passed through an adiabatic (evaporative) humidifier and leaves at 26°C DBT. Plot the process on the psychrometric chart and find (i) wet bulb temperature, relative humidity and dew point temperature at outlet, (ii) mass of water vapour added per hour, (iii) change in sensible heat (kW).

- c) During a one-hour trial on a single-cylinder four-stroke diesel engine the following data were recorded: bore = 15 cm, stroke = 18 cm, speed = 900 rpm, mean effective pressure = 8 bar, brake torque = 160 N·m, fuel consumption = 4.4 kg/h, calorific value = 42,500 kJ/kg, cooling water = 8.5 kg/min heated through 22 °C, air consumption = 140 kg/h, exhaust temperature = 380 °C, room temperature = 30 °C, c_p of exhaust gas = 1.1 kJ/kg·K. Calculate IP, BP, mechanical efficiency, brake thermal efficiency and draw the heat balance sheet on minute basis and in percentage.

Q.6 Attempt any TWO of the following:

12

- a) Draw a neat labelled sketch of a storage-type water cooler and explain the function of each component.
- b) A Morse test was carried out on a four-cylinder, four-stroke petrol engine at constant speed. The fuel consumption was 6.2 kg/h and the calorific value of the fuel is 44,000 kJ/kg. The results were:
BP with all cylinders working = 18.4 kW
BP with cylinder No. 1 cut off = 12.9 kW
BP with cylinder No. 2 cut off = 12.8 kW
BP with cylinder No. 3 cut off = 13.0 kW
BP with cylinder No. 4 cut off = 12.7 kW
Determine (i) indicated power of the engine, (ii) mechanical efficiency, (iii) brake and indicated thermal efficiencies, and state the purpose of the Morse test.
- c) Explain the summer air-conditioning system (cooling and dehumidification with reheat) with a neat sketch. Show the processes on a psychrometric chart.

Note: This is a **model question paper prepared by Ananda Technologies** only for practice and exam preparation, based on the pattern of previous MSBTE question papers and the K-scheme syllabus. It is **not an official MSBTE paper**, and it does **not** mean that these questions will come in the exam. Answers follow standard textbook points; marks shown are indicative. Free for students — anandatechnologies.in