Roll No. ..... **Total No. of Pages : 7**

1(CCE.M)3

Mechanical Engineering–II

(16)

Time : Three Hours] [Maximum Marks : 300

INSTRUCTIONS

(i) Answers must be written in English.

(ii) The number of marks carried by each question is indicated at the end of the question.

(iii) The answer to each question or part thereof should begin on a fresh page.

(iv) Your answer should be precise and coherent.

(v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

(vi) Candidates should attempt question nos. **1** and **5** which are compulsory and any **three** more out of the remaining questions, selecting at least **one** from each Section.

(vii) If you encounter any typographical error, please read it as it appears in the text-book.

(viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.

(ix) No continuation sheets shall be provided to any candidate under any circumstances.

(c) (i) List the major engine performance indicators with usual ranges for spark-ignition and compression-ignition two stroke and four stroke engines.

(ii) Describe the following with a sketch: cycle analysis for compression ignition engine and valve timing diagram for four stroke diesel engine. 20

6. (a) (i) How the different types of boilers are classified ? What are high pressure boilers ? 10

(ii) A boiler drum consists of cylindrical portion 2.4 m long, 1.2 m diameter and 24 mm thick with hemispherical ends. Water is filled at atmospheric pressure then additional water is pumped at 12 N/mm^2 pressure in test. How much water is contained in the boiler ? For boiler material E = 206 kN/mm^2, Poisson's ratio 0.3 and bulk modulus of water K = 21 $N/mm,^2$. 20

(b) (i) What is fast breeder reactor ? Explain with a sketch. 10

(ii) Explain the classification of different types of nuclear reactors. 20

7. (a) Describe the process of combustion in spark-ignition engine. With the help of a sketch explain the various stages of flame propagation and combustion in spark-ignition engine. 30

(b) Explain the following terms for internal combustion engines :

(i) Compression ratio

(ii) Brake torque and brake power

(b) Define and distinguish between :

(i) Rotational and irrotational flow

(ii) Uniform and non-uniform flow

(iii) Steady and un-steady flow 15

(c) (i) A water hose has a conical nozzle at its end. In which direction the user will feel a force while holding the nozzle by the handle ? 5

(ii) A conical reducer forms a part of piping system and rests on a support, its diameter changes from 30 cm at inlet to 20 cm at exit. Water enters the inlet with a constant average velocity of 4 m/s at an absolute pressure of 3.5 bar. The reducer weighs 100 N and contains 0.03 m^3 of water inside it. Determine the total force of the support due to reducer and the fluids in contact with it. Take atmospheric pressure as 1.03 bar. 25

3. (a) (i) Discuss the mechanism of thermal conduction in gases and solids.

(ii) Define thermal conductivity

(iii) Define the convection heat transfer coefficient. 15

(b) An exterior wall of a house is approximated by a 10 cm layer of common brick with coefficient of thermal conductivity of k = 0.7 W/m ^oC, followed by a 3.75 cm layer of gypsum plaster of thermal conductivity of k = 0.48 W/m ^oC. What thickness of loosely packed rock-wool insulation of thermal conductivity of k = 0.065 W/m ^oC should be added to reduce the heat loss or gain through the wall by 80 percent ? 15

(c) (i) Air at 300ºC and 0.7 MPa pressure is expanded isentropically from a tank until the velocity is 300m/s. Determine the static temperature, pressure and Mach number of the air at the high velocity condition. Assume $\gamma = 1.4$ for air. 15

(ii) Air at 27 ºC and 1.0 atm pressure flows over a flat plate at a speed of 2 m/s. Calculate the boundary-layer thickness at distances of 20 cm and 40 cm from the leading edge of the plate. Calculate the mass flow which enters the boundary layer between x = 20 cm and x = 40 cm. The viscosity of air at 27ºC is 1.85×10^{-5} kg/ms. Assume unit depth in the z-direction. 15

4. (a) (i) What is a weir ? How is it different from a large orifice ?

(ii) A sharp crested rectangular weir is 2 m long and has a head of 50 cm.

Calculate the discharge assuming a suitable value for coefficient of discharge and taking into consideration of effect of two end contractions. 20

(b) (i) If a Pitot tube is directed up-stream and then down-stream in a fluid stream, indicate the liquid level that rise in the tube in each case.

(ii) A Pitot tube is mounted on an airplane to indicate the relative speed of the plane. What differential pressure intensity will the instrument register when the plane is travelling at a speed of 200 km/hr in a wind blowing at 60 km/hr against the direction of motion of the plane ? Take specific weight of the air as 11.9 N/m^2. 20

(c) (i) Define fin efficiency.

(ii) What is meant by thermal resistance ?

(iii) What is meant by the term 'one-dimensional' when applied to conduction problem ? 20

SECTION–B

5. (a) (i) List five important differences between the design and operating characteristics of spark-ignition and compression-ignition engines.

(ii) Describe the major functions of the following reciprocating engine components: piston, connecting rod, crank-shaft and intake and exhaust manifolds. 20

(b) (i) A four-cylinder spark ignition engine is designed for maximum brake torque of 150 Nm in the mid-speed range of 300 rev/min. Estimate the engine displacement, bore, stroke, and maximum brake power. Assume brake mean effective pressure as 925 kPa at maximum engine torque.

(ii) A four-stroke diesel engine has a displacement of 26.1 liters. The engine has a maximum output of 900 W at 2300 rev/min and de-rated to 397.5 kW at 1800 rev/min for industrial use. What is the break mean effective pressure for each of these two types ?

For a break specific fuel consumption of 0.063 kg/MJ at maximum power and a minimum break specific fuel consumption of 0.057 kg/MJ. Calculate the overall efficiency for both conditions and the fuel rate at maximum power. The "Caloric value of fuel is 42 kg/MJ. 20

(x) Candidates shall put a cross (x) on blank pages of Answer Script.

(xi) No blank page be left in between answer to various questions.

(xii) No programmable Calculator is allowed.

(xiii) No stencil (with different markings) is allowed.

SECTION–A

1. Answer any **three** of the following :–

(a) (i) What is a thermodynamic system ?

(ii) Explain what you understand by thermodynamic equilibrium. 20

(b) Determine the absolute pressure exerted on an object submerged 1000 m below the surface of sea. The density of sea water is 1020 kg/m^3 and the acceleration due to gravity is 9.7 m/s^2. The local atmospheric pressure is 0.98 bar. 20

(c) (i) What is the Zeroth law of thermodynamics ?

(ii) What is ideal gas ? 20

(d) A platinum resistance thermometer has a resistance of 2.8 ohm at 0ºC and 3.8 ohm at 100ºC. Calculate the temperature when the resistance indicated is 0.5 ohm. 20

2. (a) A cylinder contains 0.75 m^3 of gas at 20ºC and 2.5 bar pressure. After compression, the volume gets reduced to 0.15 m^3. Determine the final pressure and bulk modulus of compressed air if compression takes place under following conditions :

(i) Isothermal conditions

(ii) Adiabatic conditions.

Assume γ = 1.4. 15

(iii) Instantaneous piston speed

(iv) Mechanical efficiency

(v) Specific fuel consumption. 30

8. (a) With the help of a schematic diagram explain a domestic refrigerator and show its four basic components.

(b) (i) What are the closed and open thermodynamic systems ?

(ii) State second law of thermodynamics and define entropy.

(c) 100 kg of ice at –5 ºC is placed in a bunker to cool some vegetables. 24 hours later the ice has melted into water at 10ºC. What is the average rate of cooling in kJ/hr and ton-refrigeration (TR) provided by the ice ?

Given : Specific heat of ice = 1.94 kJ/kg K

Specific heat of water = 4.1868 kJ/kg K

Latent heat of fusion of ice at 0ºC = 335 kJ/kg

(d) Explain the following terms of Psychometry :

(i) Wet bulb temperature and dew point temperature

(ii) Degree of saturation

(iii) Relative humidity

(iv) Absolute humidity

(v) Humidity ratio

(e) Explain vapour compression cycle with the help of T-s and p-v diagram.

(f) List three common inorganic refrigerants with their application in refrigeration. 10×6=60