RVK/KW/13/3136/3538/3253

Faculty of Engineering & Technology
Seventh Semester B.E. (Mech.)/P.E./Sixth Semester
B.E.P.T. (Mech.) Examination
ENERGY CONVERSION–II
Sections—A & B

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.
(2) Answer **THREE** questions from Section A and **THREE** questions from Section B.
(3) Due credit will be given to neatness and adequate dimensions.
(4) Assume suitable data wherever necessary.
(5) Illustrate your answers wherever necessary with the help of neat sketches.
(6) Use of Steam tables, Mollier's chart is permitted.

SECTION–A

1. (a) Prove that condition for minimum work required to run the reciprocating compressor is $P_i = \sqrt{P_s.P_d}$ where P_s = Suetion Pressure, P_d = Delivery Pressure, P_i = Intermediate Pressure. 5

(b) A single-cylinder, single acting air compressor running at 300 rpm is driven by a 23 KW electric motor. The mechanical efficiency of the drive between motor and compressor is 87%. The air inlet conditions are 1.013 bar and 23°C and delivery pressure is 8 bar. Calculate the free air delivery in m^3/min, the volumetric efficiency, and bore and stroke of the compressor. Assume that the index of compression and expansion is n = 1.3, that the clearance volume is 7% of swept volume, and that bore is equal to the stroke. 8

2. (a) A two stage single acting Reciprocating Compressor takes, in air at the rate of 0.2 m^3/s. The intake pressure and temperature of air are 0.1Mpa and 16°C. The air is compressed to a final pressure of 0.7 mPa. The intermediate pressure is ideal and intercooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 r.p.m. Neglecting clearance, determine :
(i) The intermediate pressure,
(ii) The total volume of each cylinder
(iii) The power required to drive compressor. 7

(b) Write short notes on :
(i) Multistage Compression
(ii) Effect of clearance on volumetric efficiency. 6

3. (a) How does centrifugal compressor differ from an axial flow compressor ? 4

(b) What is a slip factor and a pressure coefficient ? 4

(c) Explain the working principles of "Root blower". 5

4. In an axial flow compressor, the overall stagnation pressure ratio achieved is 4 with overall stagnation isentropic efficiency of 85%. The inlet stagnation pressure and temperature are 1 bar and 300 K. The mean blade speed is 180m/s. The degree of reaction is 0.5 at the mean radius with relative air angles of 12° and 32° at the rotor inlet and outlet respectively. The work done factor is 0.9. Calculate :

   (i) Stagnation polytropic efficiency

   (ii) Number of stages

   (iii) Inlet temperature and Pressure

   (iv) Blade height in the first stage if the hub-tip ratio is 0.42, mass flow rate is 19.5 kg/s. 13

5. (a) Explain the various stages of combustion in C.I. Engine. 6

   (b) What are the basic types of internal combustion engines ? Explain the fundamental differences. 4

   (c) Discuss detonation in S.I. Engine. 4

SECTION–B

6. (a) What are the different methods of Indicated Power Measurement ? Explain any one : 5

   (b) The following observations were recorded during the test on six cylinder four stroke engine. The air consumption measured by an air box with sharp edge orifice system.

   Orifice diameter = 30 mm

   Bore = 100 mm, Stroke = 120 mm,

   RPM = 2400, % C in fuel = 85%.

A57

   % H in fuel = 15%, Density of air = 1.16 kg/m^3

   Coefficient of discharge = 0.6,

   Pressure drop across orifice = 14.5 cm of Hg

   Fuel Consumption = 14.9 kg/hr.

   Calculate :–

   (a) Volumetric efficiency

   (b) % of excess air. 8

7. During a test on a two stroke oil engine on full load the following observations were recorded :

   Speed = 350 rpm

   Net brake load = 590 N

   Mean Effective Pressure = 2.8 bar

   Oil Consumption = 4.3 kg/ht

   Jacket Cooling Water = 500 kg/h

   Temperature of Jacket water at inlet and outlet = 25°C and 50°C respectively.

   Air used per kg of oil = 33 kg

   Temp. of air in test room = 25°C

   Temp. of exhaust gases = 400°C

   Cylindrical diameter = 220 mm

   Stroke length = 280 mm

   Effective brake diameter = 1 metre

   Calorific value of oil = 43900 KJ/kg

   Proportion of hydrogen in fuel oil = 15%

   Mean specific heat of dry exhaust gases = 1 KJ/kgk

   Specific heat of steam = 2.09 KJ/kgk

   Calculate :–

(A58)

(i) Indicated Power
(ii) Brake Power
(iii) Mechanical efficiency.

Also draw up heat balance sheet on minute basis. 13

8. (a) Explain with neat sketch the working of a const volume combustion gas turbine. 4

(b) Air is drawn in a gas turbine unit at 17°C and 1.02 bar and the pressure ratio is 8:1. The compressor is driven by the HP turbine and the LP turbine drives a separate power shaft. The isentropic efficiencies of the compressor and the HP and LP turbines are 0.8, 0.85 and 0.87 respectively. Determine :

(i) The pressure and temperature of the gases entering the power turbine

(ii) The net power developed by the unit per kg/s of mass flow

(iii) The work ratio

(iv) The thermal efficiency of the unit. The maximum cycle temperature is 650°C.

For the Compression Process,

C_p = 1.005 KJ/kg-K and γ = 1.4

For Combustion Process and Expansion Process

C_p = 1.15 KJ/kg-K and γ = 1.35 9

9. (a) What are the various methods used to improve the network done and thermal efficiency of open cycle gas turbine power plant ? 5

(b) What is difference between open cycle gas turbine and closed cycle gas turbine ? 4

(c) Explain the working principle of ram jet with neat sketch. 4

10. (a) A turbo jet engine consumes air at a rate of 60 kg/s when flying at a speed of 1000 km/hr. The exit velocity of jet is 651 m/sec. Calculate : –

(i) Fuel flow rate in kg/s when air fuel ratio is 70:1

(ii) Thrust

(iii) Thrust specific fuel consumption

(iv) Thermal efficiency when consumption efficiency is 92% and CV of fuel used is 42 MJ/kg

(v) Overall efficiency. 10

(b) Explain the working principle of jet propulsion. 4