B.E.(Mechanical / Power Engineering) Semester Seventh (C.B.S.)

Energy Conversion - II

P. Pages : 3 **KNT/KW/16/7475/7521**

Time : Three Hours * 0 8 7 0 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Assume suitable data wherever necessary.
9. Use of non programmable calculator is permitted.
10. Use of steam table, refrigeration table and psychrometric chart is permitted.

1. a) What do you mean by multistage compression ? State its advantages. **4**

b) A 2-stage reciprocating compressor takes air at the rate of 0.2 m^3/sec, the intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a final pressure of 0.7 MPa. The intercooling is perfect. The compression index in both the stages is 1.25 and compressor runs at 600 rpm. Neglecting clearance, Determine : **9**

i) Intermediate pressure
ii) Volume of each cylinder
iii) Power required to drive the compressor

Take mech. Efficiency 80%, Cp = 1.005 kJ/kgK, R = 287 J/kgK.

OR

2. a) A single stage double acting air compressor delivers air at 7.5 bar. The pressure and temperature at the end of suction stroke are 1 bar and 25°C. It delivers 2.2 m^3 of free air per minute at 310 rpm. The clearance volume is 5% of stroke volume. The pressure and temperature of ambient air are 1.013 bar and 20°C. Determine **8**

i) Volumetric efficiency
ii) Diameter and stroke length of cylinder if both are same

Take index of compression and expansion as 1.25 and 1.3 respectively.

b) Derive an expression for volumetric efficiency of single stage reciprocating air compressor $n_{vol} = 1 + k - k(p_2 / p_1)^{1/n}$. **5**

3. a) A centrifugal compressor running at 12000 rpm delivers 600 m^3/min of free air. The air is compressed from 1 bar and 27°C to pressure ratio of 4 with an isentropic efficiency of 85%. The blades are radial at the impeller outlet and flow velocity of 60 m/s may be assumed throughout const. The outer radius of the impeller is twice the inner one and slip factor is 0.9. find : **8**

i) Find temp. of air
ii) Power input to compressor
iii) Impeller diameter at inlet and outlet
iv) Width of impeller at inlet.

b) Write short note on : **5**

i) Static and total head quantities.

ii) Surging and choking.

OR

4. a) An axial flow compressor of 50% reaction design has blades with inlet and outlet angles of 45º and 10º respectively. The compressor is to produce a pressure ratio of 6:1, with an overall isentropic efficiency of 85% when the air inlet temperature is 40ºC. The blade speed and axial velocity are constant throughout the compressor. Assume a value of 200 m/sec for the blade speed find the number of stages required when the work factor is 0.9 for all stages. **7**

b) Explain the construction and working of a roots blower with a neat sketch. **6**

5. a) Explain the stages of combustion in S.I. engine with P-Q. diagram. **5**

b) Explain the knocking and detonation phenomenon in C.I. Engine. **5**

c) State the merits and de-merits of four stroke engines over two stroke engines. **4**

OR

6. a) Describe working of simple carburetor with neat sketch. **5**

b) Draw a neat sketch of any one lubrication system used in automobile. Also explain it. **5**

c) Sketch a valve timing diagram for a Diesel Engine operating on four stroke cycle. **4**

7. a) Explain method used for finding the frictional power of a multicylinder engine. **4**

b) The power output of a six-cylinder four stroke engine is absorbed by a water brake for which the law is WN/20,000 where the brake load W is in Newton and the speed is in rpm. An air box with sharp edge orifice system measures the air consumption. The following readings are obtained. Orifice diameter = 30 mm, Bore = 100 mm, Stroke = 120 mm, C/H ratio by mass = $\frac{83}{17}$, coefficient of discharge = 0.6, Ambient pr. = 1 bar Ambient temperature = 27ºC, Fuel density = 831 kg/m^3 pressure drop across orifice = 14.5 cm of Hg Time taken for 100 cc of fuel consumption = 20 sec. Determine : **10**

i) Brake power ii) BSFC

iii) Percentage of excess air iv) Volumetric efficiency

OR

8. The following observations were recorded during the test conducted on a single cylinder 4 stroke CI engine, Bore-250 mm, Stroke = 600 mm, Area of Indicator diagram = 4.50 cm^2, Length of indicator diagram = 7 cm, Spring stiffness = 8.30 N/cm^2 per mm, Engine Speed = 350 rpm, Load on Hydraulic Dynamometer = 1050 N, Dynamometer Constant = 10000, Fuel consumption = 11.2 kg/hr, Calorific value of fuel = 42 MJ/kg, Mass of cooling water = 1020 kg/hr Temp. rise of cooling water = 25ºC, Fuel analysis (by mass) : C = 85%, H_2 = 13.5%, Incombustible = 1.5% **14**

Exhaust Gas Analysis (by volume) CO_2 = 8%, O_2 = 11%, N_2 = 81%
Temp. of Exhaust gases = 400ºC, Room temp. = 25ºC
Partial pressure of steam in exhaust gases 0.035 bar specific heat for superheated steam and dry exhaust gases 2.1 and 1.005 kJ/kg K respectively.

Take $BP = \frac{WN}{C} KW$

Calculate brake specific fuel consumption and mechanical efficiency. Also draw up a heat balance sheet on percentage and on minute basis.

9. A vapour compression refrigeration system with R-12 as a refrigerant handles refrigeration load of 14 kw for the chemical processing plant. The evaporator temp. is -5ºC and the condenser temp. is 40ºC. The refrigerant is subcooled by 5ºC before entering the expansion valve the vapour is superheated by 6ºC before entering the compressor. The compression may be assumed to be isentropic. The compressor is running at 1000 rpm and is having two cylinders with piston stroke 1.5 times as that of piston dia. The clearance for the compression is 2%. Determine : **13**

i) Refrigerating effect
ii) mass flow rate of refrigerant in kg/min
iii) COP
iv) Compressor volumetric efficiency
v) Compressor bore and stroke length

Take liquid specific heat = 0.963 kJ/kg k
Vapour specific heat = 0.7035 kJ/kg k

OR

10. a) Sketch and explain in brief the working of simple vapour absorption system. Give suitable industrial applications where this system can be used with advantage over vapour compression refrigeration system. **8**

b) How are refrigerants classified. Explain desirable properties of a refrigerant. **5**

11. a) A restaurant having a capacity of 100 seats is to be air conditioned, when out door conditions are 30ºC DBT and 70% RH. Desired inside conditions are 23ºC DBT and 55% RH. The quantity of out door air supplied is 0.5 m^3/min/person. **8**
The desired conditions are achieved by cooling and dehumidifying and then heating, find

i) Capacity of cooling coil
ii) Capacity of heating coil
iii) Amount of water vapour removed by dehumidifier
iv) By pass factor of heating coil, if its surface temperature is 35ºC.

b) Describe the summer air conditioning system with neat sketch. **5**

OR

12. a) Air enters an evaporative desert cooler at 1 bar, 45ºC and 20% RH at the rate of 50 m^3/minute and it leaves with relative humidity of 60%. Find the cooling efficiency and minimum temperature to which air can be cooled. What is the rate of evaporation of water? **8**

b) Explain air washer and what are the methods of obtaining humidification and dehumidification ? **5**

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