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

Energy Conversion - II

P. Pages : 4 **NRT/KS/19/3559/3605**

Time : Three Hours * 0 2 9 4 * 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 whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.
11. Use of steam table, refrigeration table & chart, psychrometric chart are permitted.

1. a) Prove that the volumetric efficiency of a single state compressor is given by **5**

$$\eta_{vol} = 1 + k - k\left(\frac{p_2}{p_1}\right)^{1/n}, \text{ where } k = \frac{V_c}{V_s},$$

$p_1 \rightarrow$ suction pressure and p_2 =Delivery pressure and n = Index of expansion.

b) State the conditions which lower the volumetric efficiency. **2**

c) A single stage, single acting air compressor running at 1000 rpm delivers air at 25 bar. For this purpose the induction and free air conditions can be taken as 1.013 bar and 15°C, and the free air delivery as 0.25 m^3/min. the clearance volume is 3% of the swept volume and stroke/bore ratio is 1.2:1. Take index of compression and expansion as 1.3. Determine : **6**
i) The indicated power and ii) the bore and stroke of this machine.

OR

2. a) Explain the multistage compression and state its advantages. **3**

b) A single - acting two stage compressor with complete intercooling delivers 10 kg/min of air at 16 bar. The suction occurs at 1 bar and 15°C. the expansion and compression processes are reversible polytropic with polytropic index n = 1.25. Calculate : **10**
i) The power required to drive the compressor.
ii) Heat transferred in intercooler.
iii) If the clearance ratio for LP and HP cylinder are 0.04 and 0.06 respectively, Calculate the swept volume and clearance for each cylinder take speed of the compressor is 400 rpm.

3. a) Explain with the help of neat sketch and P-V diagram, the construction and working of wave blower. **5**

b) A centrifugal compressor delivers 16.5 kg/s of air with a total head pressure ratio of 4:1. The speed of compressor is 15000 rpm. Inlet total head temperature is 20ºC, slip factor 0.9, power input factor 1.04 and isentropic efficiency 80%, calculate : **8**

i) Overall diameter of the impeller
ii) Power input to the compressor.

OR

4. a) Explain the following terms related to rotary air compressor : **6**

i) Surging and Choking
ii) Degree of reaction
iii) Pre-Whirl

b) An axial flow air 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 33ºC. The blade speed and axial velocity are constant throughout the compressor. Assume a value of 200 m/s for the blade speed, find the number of stages required when work factor is 0.89 for all stages. **7**

5. a) Describe with a suitable sketch the two stroke cycle spark ignition engine. **5**

b) Describe a simple carburetor with a neat sketch and also state its limitation. **5**

c) Discuss the difference between ideal and actual valve timing diagram of a 2S diesel engine. **4**

OR

6. a) Explain the phenomena of knocking in S.I. engine. What are the different factors which influence the knocking ? Describe the method to suppress it. **5**

b) Explain the stages of combustion in C.I. engines with the help of P-θ diagram. **5**

c) Explain the components of fuel injection system system in C.I. engine. **4**

7. a) Explain the method of determination of indicated power of a multi-cylinder engine. **4**

b) A 4-cylinder petrol engine has an output of 5 kw at 2000 rpm. A Morse test is carried out and the brake torque readings are 177, 170, 168 and 174 Nm respectively. For the normal running at this speed the specific fuel consumption is 0.364 kg/kwh. The calorific value of fuel is 44200 kJ/kg. Determine : **9**

i) Mechanical efficiency
ii) Brake thermal efficiency of the engine.

OR

8. During the trial of a single cylinder, 4-stroke diesel engine the following observations were recorded : Bore = 350 mm, Stroke = 450 mm, rpm = 400, area of indicator diagram = 472 mm^2, length of indicator diagram = 62 mm, spring constant = 0.59 bar/mm, load on hydraulic dynamometer = 970 N, dynamometer constant = 7500, fuel used= 10.78 kg/n, calorific value of fuel = 50000 kJ/kg, cooling water circulated = 24 litres/min, **13**

rise in temperature of cooling water = 24ºC. The mass analysis of fuel is : Carbon = 84%, hydrogen = 15%, incombustible = 1%. The volume analysis of exhaust gases is : Carbon dioxide = 8%, Oxygen = 11%, nitrogen = 81%.
Temperature of exhaust gases = 380ºC, Specific heat of exhaust gases = 1.05 kJ/kg k, ambient temperature = 20ºC, partial pressure of steam in exhaust gases = 0.03 bar, specific heat of superheated steam = 2.1 kJ/kg k. Draw up the heat balance sheet on percentage and minute basis.

9. a) Discuss the desired characteristics of refrigerant used in vapour compression system. Also give nomenclatures of refrigerant based on methane and ethane. **6**

b) A vapour compression refrigeration uses R-12 as refrigerant and the liquid evaporates in the evaporator at -15ºC. The refrigerant leaves the compressor at dry saturated vapour at-15ºC. Find **8**

i) COP if there is no undercooling

ii) COP if the liquid is subcooled by 5ºC &

iii) Percentage increase in COP due to subcooling $C_{p\ liquid}$ = 0.747 kJ/kg k

OR

10. a) Sketch and explain in brief the working of simple vapour absorption system. Also give its advantage over VCR system. **5**

b) A food storage locker require a refrigeration capacity of 50 kw. It works between condenser temperature of 35ºC and an evaporator temperature of -10ºC. The refrigerant is ammonia. It is subcooled by 5ºC before entering the expansion valve and dry saturated vapour leaves an evaporator. Assume single cylinder, single acting compressor operating at 1000 rpm with stroke equal to 1.2 times the bore. Determine : **9**
i) The power required to drive the compressor
ii) The cylinder dimension and iii) COP of system
$C_{p\ liquid}$ = 4.556 kJ/kg k , $C_{p\ vapour}$ = 2.903 kJ/kg k

11. a) Explain the following terms related with moist air **4**

i) Specific humidity ii) Dew point temperature

iii) Degree of saturation iv) Wet bulb temperature

b) The reading from a sling psychrometer are as follows : **9**
Dry bulb temperature = 30ºC, wet bulb temperature = 20ºC ;
Barometric reading = 740 mm of Hg. Using steam tables, determine :

i) Dew point temperature ii) Relative humidity

iii) Specific humidity iv) Degree of saturation

v) Vapour density and vi) Enthalpy of mixture per kg of dry air.

OR

12. a) Explain the following psychrometric processes using air washer **4**

i) Cooling and dehumidification

ii) Heating and humidification.

b) The air at 30ºC dry bulb temperature and 60º relative humidity is passed through a cooling coil at the rate of 250 m^3/min. The air leaves the cooling coil at 14ºC dry bulb temperature. If by-pass factor is 0.1. Determine : **9**

i) The surface temperature of the cooling coil (ADP)

ii) Relative humidity of the air leaving the cooling coil.

iii) Sensible heat factor, and

iv) Cooling coil capacity in kw.

Use psychrometric chart.

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