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

Energy Conversion - II

P. Pages : 3 **NKT/KS/17/7475/7521**

Time : Three Hours * 0 1 5 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. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.
12. Use of steam table, refrigeration table is permitted.

1. a) What is the need of multistage compression & state its advantages. **5**

b) A single stage double acting air compressor delivers air at 7.5 bar. The pressure & temperature at the end of suction stroke are 1 bar and 25ºC. It delivers $2.2\,m^3$ of free per minute at 310 rpm. The clearance volume is 5% of stroke volume. The pressure and temperature of ambient air are 1.03 bar and 20ºC. Take index of compression and expansion are 1.25 and 1.3 respectively. Determine : (1) Volumetric efficiency (2) Diameter and stroke length of cylinder if both are equal. (3) I.P. & B.P., if mechanical efficiency is 80%. **9**

OR

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

$$\eta_{vol} = 1 + C - C\left(r_p\right)^{1/n}$$

Where, C = Clearance ratio, r_p = Pressure Ratio & n = polytropic index.

b) A two stage reciprocating air compressor delivers air at 17.25 bar has clearance volume of L. P. cylinder = 4% of swept volume. The atmospheric pressure is 1 bar and temperature is 15ºC. At the start of compression the pressure in cylinder is 0.98 bar & 32ºC. Intercooling pressure in cylinder is 4 bar. Take index of compression & expansion as 1.25 Find : **9**

a) Work done per kg.
b) Volumetric efficiency refer to atmospheric condition.
Assume P atm = 1. bar T atm = 25ºC.
c) Isothermal efficiency
d) Saving in work as compared with single stage.

3. a) Explain with the help of neat sketch and p - v diagram a Root air blower. **5**

b) A centrifugal compressor used as a super charger for aero - engines handles 150 kg/min of air. The suction pressure & temperature are 1 bar and 290 K. The suction velocity is 80 m/s. After compression in the impeller the conditions are 1.5 bar, 345 K and 220 m/s. Calculate : **8**

i) Isentropic efficiency ii) Power required to drive the compressor
iii) The overall efficiency of the unit

It may be assumed that K.E. of air gained in the impeller is entirely converted into pressure in the diffuser.

OR

4. a) Differentiate between axial flow compressor and centrifugal compressor. **5**

b) In an eight stage axial flow compressor, the overall stagnation pressure ratio achieved is 5:1 with an overall isentropic efficiency of 92%. The mean blade speed is 160 m/s and 50% reaction design is used. The axial velocity through the compressor is constant and is equal to 90 m/s. The inlet stagnation temperature & pressure at inlet are 290 K & 1 bar. The work is divided equally between the stages. **8**

Calculate :

i) The blade angles

ii) The power required.

5. a) Differentiate between two stroke & four stroke engines. **4**

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

c) Explain with neat sketch the working of simple carburetor. States its limitations. **5**

OR

6. a) Differentiate between SI & CI engines. **4**

b) Explain Morse test method to determine I.P. of multi cylinder engine. **5**

c) Explain the phenomenon of knocking in S.I. Engines. **5**

7. a) Describe the laboratory method used for measuring the air supplied to an I.C. engines. **5**

b) The power output of a six cylinder four stroke engine is measured by a hydraulic dynamometer for which the law is $\frac{WN}{20,000}$, where W is in Newton and the speed N is in rpm. **8**

The air consumption is measured by air box method. The following reading are obtained :

Orifice diameter = 30 mm, Stroke = 120 mm

bore = 100 mm, brake load = 560 N.

Coefficient of discharge of orifice = 0.6

ambient pressure = 1 bar, pressure drop across orifice = 14.5 cm of hg.

Time taken for $100\,cm^3$ of fuel consumption is 20 sec, ambient temperature = 27ºC,

fuel density = $835\,kg/m^3$, Speed = 2400 rpm.

Calculate :

(a) B.P.

(b) B.S.F.C.

(c) Volumetric efficiency.

OR

8. During test of four stroke, eight cylinder petrol engine the following data was obtained : **13**
Load on hydraulic dynamometer = 950 N, Speed = 1250 rpm, bore = 70 mm, stroke = 89 mm, fuel consumption = 19.5 kg/hr, Calorific value of fuel used = 43 MJ/kg. Jacket water flow = 1400 kg/hr, Rise in water jacket temperature = 30ºC, Air fuel ratio = 32, Room temperature = 30ºC. exhaust gas temperature = 400ºC, fuel analysis : 15% H_2 & 85% C, Specific heat of vapour =2.09 KJ/kgK, Partial pressure of water vapour in exhaust gas= 0.02 bar, specific heat of gases = 1.005 KJ/kgK, Constant of hydraulic dynamometer = 17280. Draw heat balance sheet in KJ/sec. & % basis.

9. a) Explain the effect of superheating & subcooling on a simple vapour compression refrigeration cycle. **5**

b) In a vapour compression refrigeration system the data available is as follows : **8**
Diameter of 2 cylinder single acting compressor = 15 cm. Length of stroke = 14 cm, $\eta_r = 80\%$, R.P.M. = 250, evaporator & condenser temperature are -15^oC & 30ºC. Liquid ammonia enters expansion valve at 21ºC. Find : (i) Refrigeration capacity of plant (ii) C.O.P.
Take : $Cp_{liquid} = 4.6 KJ/kgK$
$Cp_{vapour} = 2.46 KJ/kgK$,
Use following table.

Temperature (ºC)	Specific volume m^3/kg	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/KgK)	S_g (KJ/KgK)
- 15	0.509	112.3	1426	0.457	5.549
30	0.111	323.1	1469	1.204	4.984

OR

10. a) Explain with neat sketch the simple vapour absorption refrigeration system. **5**

b) A R-12 installation has following data. **8**
Temperature of refrigerant superheated as gas in the evaporator = - 5ºC
Capacity : 15TR, evaporator temperature = - 10ºC
Condenser temperature : 30ºC
Temperature of refrigerant subcooled as liquid in the condenser : 25ºC
Compressor particulars : No. of cylinder = 2
bore is 1.5 times stroke, rpm is 960
Determine :
a) Mass of refrigerant circulated per minute.
b) COP
c) Volumetric efficiency, piston displacement, bore & stroke of the compressor; if the clearance volume is 3% of stroke volume.

11. a) Define the following terms related with moist air. **5**
i) Degree of saturation
ii) Wet bulb temperature
iii) Relative humidity
iv) Specific humidity
v) Dew point temperature

b) With the help of steam table; determine (i) partial pressure of water vapour, (ii) dew point temperature, (iii) relative humidity, (iv) specific humidity & (v) specific enthalpy; if dry bulb temperature reads 40ºC and wet bulb temperature is 30ºC. Barometer reads 740 mm of Hg. **8**

OR

12. a) In a cooling application, moist air enters refrigeration coil at a rate of 100 kg of dry air per minute at 35ºC & 50% RH. The apparatus due point of coil is 5ºC & by pass factor is 0.15. Determine the outlet state of moist air and cooling capacity of coil in T.R. **9**

b) Describe the detail of working of air washer. **4**

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