University of Engineering & Technology

Seventh Semester B.E. (Mech. Engg.)/P.E. (C.B.S.)

Examination

ENERGY CONVERSION-II

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.
(2) Solve Question No. **1 OR** Question No. **2**.
(3) Solve Question No. **3 OR** Question No. **4**.
(4) Solve Question No. **5 OR** Question No. **6**.
(5) Solve Question No. **7 OR** Question No. **8**.
(6) Solve Question No. **9 OR** Question No. **10**.
(7) Solve Question No. **11 OR** Question No. **12**.
(8) Assume suitable data wherever necessary.
(9) Illustrate your answers wherever necessary with the help of neat sketches.
(10) Use of non programmable calculator is permitted.
(11) Use of steam table, refrigerant table and psychrometric chart is permitted.

1. (a) Derive the condition for minimum work per kg of air delivered with two-stage air compressor with perfect intercooling. 5

(b) A two cylinder single acting air compressor is to deliver 16 kg of air per minute at 7 bar from suction conditions of 1 bar and 15^0C. Clearance may be taken as 4% of stroke volume and the index for both compression and expansion as 1.3. Compressor is directly coupled with four cylinder, 4-stroke petrol engine which runs at 2000 rpm with break mean effective pressure of 5.5 bar. Assuming a stroke bore ratio of 1.2 for both engine and compressor and a mechanical efficiency of 82% for compressor, calculate the required cylinder dimensions of compressor and engine. 8

OR

2. A single acting two stage air compressor with complete intercooling delivers 10 kg/min of air at 16 bar. The suction occurs at 1 bar and 18^0C. The expansion and compression process are polytropic with an index n = 1.27. The speed of the compressor is 400 rpm. Calculate :

(i) Power required

(ii) Isothermal efficiency

(iii) Free air delivered in m^3/min

(iv) Heat transferred in intercooler

(v) If the clearance ratios for LP and HP cylinders are 0.04 and 0.06 respectively, calculate swept and clearance volumes for each cylinder. 13

3. (a) Explain the following terms related to rotary air compressor

(i) Surging

(ii) Choking. 5

(b) An axial flow air compressor comprises a number of similar stages with equal work done/stage and velocity of flow is uniform throughout the compressor. The data is as follows :

Overall stagnation pressure ratio = 3.5

Stagnation inlet temperature = 60^0C

Relative air angle at rotor inlet = 50^0

Relative air angle at rotor outlet = 80^0

Balance velocity = 185 m/s

Degree of reaction = 50%

Overall stagnation adiabatic efficiency = 87%

Calculate :

(i) Stagnation outlet temperature

(ii) Number of stages. 8

OR

4. (a) Compare centrifugal and axial flow compressor. 3

(b) The following data pertaining to a centrifugal compressor.

Total pressure ratio = 3.6:1

Diameter of inlet eye of compressor impeller = 35cm

Axial velocity at inlet =140 m/s

Mass flow of air = 12 kg/s

Velocity in the delivery duct = 120 m/s

Tip speed of impeller = 460 m/s

Speed of impeller = 16000 rpm

Total head isentropic efficiency = 80%

Pressure coefficient = 0.73

Ambient conditions = 1.013 bar and 15^0C.

Calculate :

(i) The static pressure and static temperature at compressor inlet and outlet.

(ii) The static pressure ratio.

(iii) Work of compressor per kg of air.

(iv) Theoretical power required. 10

5. (a) Define carburetion. Explain with neat sketch the working of simple carburettor. 5

(b) Explain the phenomenon of combustion in CI engine with the help of P-Q diagram. 5

(c) Differentiate between SI and CI engines. 4

OR

6. Write short notes on (any **three**)

(i) Fuel injection in C.I. engine.

(ii) Theoretical and actual valve timing diagram of 4-stroke, SI engine.

(iii) Working of 2-stroke, SI engine

(iv) Factors affecting abnormal combustion in CI engine.

(v) Detailed classification of engines. 14

7. (a) Describe the method commonly used in laboratories for measuring the air supplied to an I.C. engine. 5

(b) For a 6 cylinder, 4-stroke SI engine, the following data is obtained.

Compression ratio = 6

Brake power = 312 kW

Speed of engine = 2500 rpm

Stroke length = 1.25 times bore

Mechanical efficiency = 82%

Indicated mean effective pressure = 10 bar

Relative efficiency = 50%

Calorific value of fuel = 43960 kJ/kg

Find :

(i) Bore and stroke of engine

(ii) Brake specific fuel consumption

(iii) Brake thermal efficiency. 8

OR

8. The following data is given for a 4 stroke 4 cylinder diesel engine.

Diameter of the cylinder = 35 cm

Piston stroke = 40 cm

Speed of the engine = 315 rpm

Indicated mean effective pressure = 7 bar

Brake power of the engine = 250 kW

Fuel consumption = 80 kg/hour

Calorific value of fuel = 43000 kJ/kg

Hydrogen content in fuel = 13%

Percentage of carbon in fuel = 87%

Air consumption = 30 kg/min

Cooling water circulated = 90 kg/min

Rise in temperature of cooling water = 38^0C

Piston cooling oil used = 45 kg/min

Rise in temperature of cooling oil = 23^0C

Cp for cooling oil = 2.2 kJ/kg K

Exhaust gas temperature = 322^0C

Cp for exhaust gas = 1.1 kJ/kg K

Ambient termperature = 22^0C

Cp for superheated steam = 2kJ/kg K

Latent heat of steam = 2520 kJ/kg.

Find :

(i) The mechanical and indicated thermal efficiency

(ii) Draw the heat balance sheet on minute and percentage basis. 13

9. (a) A Vapour compression machine with R-12 as refrigerant has a capacity of 20 TR operating between -28^0C and 26^0C. The refrigerant is subcooled by 4^0C before entering the expansion valve and vapour is superheated by 5^0C before leaving the evaporator.

The machine has six cylinder single acting compressor with L = 1.25 D and has a clearance of 3% of the stroke volume. Assume speed of compressor = 1000 rpm.

Determine :

(i) Theoretical power required

(ii) COP

(iii) Volumetric efficiency

(iv) Bore and stroke of cylinder. 9

(b) Explain with neat sketch the working of a simple Vapour Absorption Refrigeration System. 5

OR

10. (a) Discuss in detail the effect of subcooling and superheating on COP of vapour compression refrigeration system. Also represent on J-S and P-h chart. 5

(b) Discuss the desirable properties of an ideal refrigerant. 3

(c) Write in brief on following :

(i) Air refrigeration system

(ii) Refrigerant nomenclature. 6

11. (a) Define the following terms :

(i) Specific humidity

(ii) Relative humidity

(iii) Dew point temperature

(iv) Degree of saturation. 4

(b) Explain the following processes :

(i) Cooling and dehumidification

(ii) Heating and humidification. 5

(c) Explain with neat sketch and psychrometric chart winter air conditioning system. 4

OR

12. (a) A restaurant is required to be maintained at 22^0C DBT and 70% RH. The ambient conditions are 30^0C DBT and 80% RH. The amount of free air circulated is $200m^3$/min. The required conditions are first achieved by cooling and dehumidifying through cooling coil having ADP of 14^0C and then by heating with the help of psychrometric chart, evaluate :

(i) Capacity of cooling coil in TR and its by-pass factor.

(ii) Amount of water vapour removed by cooling coil in kg/hr.

(iii) Capacity of cooling coil in kW and its surface temperature by assuming BPF = 0.2 8

(b) Write in short on the following :

(i) Factors affecting human comfort

(ii) Evaporative cooling. 5