**B.E. (E.E.) Part-III 5th Semester Examination, 2012-13**

# Heat Power (ME-506)

**Time-3 hours** **Full Marks: 70**

**Use separate answer script for each half.**
**Answer SIX questions, taking THREE from each half.**
**The questions are of equal value.**
**Use of Steam Table, Mollier Diagram and Psychrometric Chart allowed.**

## FIRST HALF

1. (a) What is compressor? Classify compressors.
   (b) Find the expressions of work input required for compressing 1 kg. of air by reciprocating air compressor for the following cases:
   (i) without clearance (ii) with clearance, and show that clearance does not affect the work input.

2. (a) In a two stage air compressor, prove that the work done in compression is minimum when the intermediate pressure is the geometric mean between the initial and final pressures in case of perfect inter-cooling between the two stages.
   (b) A single stage double acting air compressor of 8.25 kW of i.p. at 135 r.p.m. takes air at 1.013 bar and delivers at 10.13 bar. Assuming the law of compression and expansion as $PV^{1.35}$ = constant, find the diameter and stroke of the cylinder.
   Take piston speed = 220m/min, volumetric efficiency = 87%. Also, find the clearance volume as percentage of stroke volume.

3. (a) What is the difference between b.p. and i.p. of I.C. engine?
   (b) What is Morse test? Explain the test. What is the assumption of this test?
   (c) A four cylinder, 4-stroke petrol engine 8 cm bore and 11 cm stroke was tested at constant speed. The fuel supply was fixed to 5.45kg/hr and plugs of 4 cylinders were successively short-circuited without change of speed. The brake power measurements were as follows:
   With all cylinders working = 14.84 kW.
   With cylinder no. 1 cut off = 10.36 kW.
   With cylinder no. 2 cut off = 10.45 kW.
   With cylinder no. 3 cut off = 10.48 kW.
   With cylinder no. 4 cut off = 10.26 kW.
   Find (i) i.p. of the engine (ii) mechanical efficiency (iii) indicated thermal efficiency, if the calorific value of the fuel used is 42000 kJ/kg and, (iv) also find the relative efficiency on i.p. basis assuming clearance volume as 100 $cm^3$.

4. (a) Draw the Rankine cycle on a T-S diagram mentioning the different processes. Deduce an expression of the Rankine efficiency.
   (b) In a simple Rankine cycle, the steam at inlet to the turbine is dry saturated at a pressure of 42 bar and the exhaust pressure is 0.035 bar. Calculate (i) the Rankine efficiency
   (ii) the work ratio (iii) the specific steam consumption and, (iv) the mean temperature of heat addition. Assume the specific volume of saturated water at 0.035 bar is equal to 0.001$m^3$/kg.

5. Write short notes on **any three** of the following:
   (a) Any one method of measuring brake power of an I.C. engine.
   (b) Advantages of multistage compressors.
   (c) Comparison between S.I. and C.I. engines.
   (d) Volumetric efficiency of a reciprocating compressor.
   (e) Classification of internal combustion engines.

## Second Half

*Attempt any three from this half. All questions are of equal value. Unassigned marks reserved for neatness. Use of property tables/diagrams permitted.*

6. (a) Differentiate between point and path functions and give examples of each. Show that internal energy is a point function and doesn't depend on the path.

A gas turbine plant uses an air compressor to compress air from 100 kPa to 1.5 MPa. At the compressor discharge, the air velocity is 90 m/s and its temperature is 430°C. At the suction, air is at ambient temperature of 30°C and its inlet velocity is negligible. If the compressor consumes 5 MW of power, estimate the air mass flow rate, assuming the compressor to be a steady flow device and neglecting any heat loss.

[5 + 6]

7. (a) How could you show that the two statements of second law are equivalent?

(b) Define coefficient of performance (COP) for a heat pump and for a refrigeration plant and relate the two considering revered Carnot cycle.

Consider a heat pump to heat up a house in winter so as to maintain a steady inside temperature of 20°C at a given outside temperature of -10°C. To make up the heat loss from the house, heat is to be supplied at a rate of 25kW. Assuming an ideal heat pump, estimate the work input required for the HP and also the COP of the same.

[4 + 7]

8. (a) On a P-T diagram, show the fusion, evaporation and sublimation curves for ice-water-steam system. On the diagram, locate the triple and critical points and show isobaric heating of water from solid to vapor phases.

(b) State the working principle of a Throttling Calorimeter. A boiler was producing steam at 1 MPa. To ascertain the quality of the steam, a throttling calorimeter was used and after throttling to the ambient (100kPa), the steam temperature was recorded to be 120°C. Comment on the quality of the steam produced by the boiler.

[5 + 6]

9. (a) Explain briefly, with neat TS diagram, how increased boiler pressure and increased superheat improve the performance of a Rankine cycle power plant.

(b) How does a deaerator differ from a traditional closed type feed water heater? Draw a simple Rankine cycle plant with superheated steam at turbine inlet and one deaerator in the feed line and no other feed water heaters. Give the energy balance equations for the turbine, the deaerator, the condensate extraction pump (CEP) and the boiler feed pump (BFP).

[5 + 6]

10. (a) Define specific humidity and relative humidity and express them in terms of vapor partial pressure. Relate the two.

(b) On a certain day, the ambient air DBT and RH were found to be 35°C and 40% respectively. Determine vapor partial pressure and specific humidity, assuming atmospheric pressure as 100 kPa. What will be the dew point temperature corresponding to the prevailing vapor pressure?

[5 + 6]