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Question Paper Code: 41073

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2015.

Fourth Semester

Mechanical Engineering

01UME404 – THERMAL ENGINEERING

(Regulation 2013)

(Use of Steam table, Refrigration table, Mollier chart, Psychrometric chart are permitted)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions.

PART A - (10 x 2 = 20 Marks)

1. Sketch the PV and TS diagram of Diesel cycle.
2. Define mean effective pressure of Otto cycle.
3. Differentiate between brake power and indicated power of an IC engine.
4. Why diesel engines are more efficient than petrol engines?
5. What is critical pressure ratio of a steam nozzle?
6. What is blading efficiency?
7. Indicate the applications of reciprocating compressors in industry.
8. Define clearance ratio of an air compressor.
9. What is meant by COP of refrigeration?
10. Define Ton of refrigeration.

PART - B (5 x 16 = 80 Marks)

11. (a) (i) Derive an expression for the air standard efficiency of Brayton (Joule) cycle in terms of pressure ratio. (12)

(ii) The efficiency of an Otto cycle is 60% and $\gamma = 1.5$. What is the compression ratio? (4)

Or

(b) The volume ratios of compression and expansion for a diesel engine as measured from an indicator diagram are 15.3 and 7.5 respectively. The pressure and temperature at the beginning of the compression are 1 *bar* and *27°C*. Assuming an ideal engine,

(i) Determine the mean effective pressure, the ratio of maximum pressure to mean effective pressure and cycle efficiency.

(ii) Also find the fuel consumption per *kWh* if the indicated thermal efficiency is 0.5 of ideal efficiency, mechanical efficiency is 0.8 and the calorific value of oil 42000 *kJ/kg*?

Assume for air: $c_p = 1.005$ *kJ/kg K*; $c_v = 0.718$ *kJ/kg K*, $\gamma = 1.4$. (16)

12. (a) (i) Explain the magneto ignition system used in S.I. engines with a line diagram and state its application? (10)

(ii) What are the desirable properties and functions of a good lubricant? (6)

Or

(b) During a test on a four-stroke cycle diesel engine the following data results were obtained:

Mean height of the indicator diagram = 21 *mm*
Spring index = 27 *kN/m^2/mm*
Swept volume of the cylinder = 14 *liters*
Speed of the engine = 396 *rpm*
Net load on the brake = 0.7554 *kN*
Radius of the brake drum = 0.7 *m*
Fuel consumption = 7.2 *kg/hour*
Calorific value of fuel = 44000 *kJ/kg*
Cooling water circulation = 540 *kg/hr*
Rise in temperature of cooling water = 33*°C*
Specific heat of water = 4.18 *kJ/kg*
Energy to exhaust gases = 33.*6 kJ/s*
Determine,

(i) Mechanical efficiency

(ii) The heat balance sheet expressed as *kJ/s* and as percentage of heat supplied to engine. (16)

13. (a) (i) What is the fundamental difference between the operation of impulse and reaction steam turbine? (6)

(ii) Define the following terms: (1) Diagram efficiency (2) Stage efficiency (4)

(iii) What is governing of turbines? Explain bypass governing. (6)

Or

(b) Steam at 10.5 *bar* and 0.95 dryness is expanded through a convergent-divergent nozzle. The pressure of steam leaving the nozzle is 0.85 *bar*. Find, (i) velocity of steam at throat for maximum discharge (ii) area at exit (iii) steam discharge if the throat area is 1.2 cm^2. Assume the flow is isentropic and there are no friction losses. Take *n=1.135*. (16)

14. (a) A single stage double acting air compressor is required to deliver 14 m^3 of air per minute measured at 1.013 *bar* and *15°C*. The delivery pressure is 7 *bar* and the speed 300 *rpm*. Take the clearance volume as 5*%* of the swept volume with the compression and expansion index of *n=1.3*, Calculate
(i) Swept volume of the cylinder
(ii) The delivery temperature
(iii) Indicated power (16)

Or

(b) (i) Explain with a help of a neat sketch the principle of operation of a centrifugal air compressor. (10)
(ii) List out the merits and de-merits of Multistage air compressor. (6)

15. (a) With a neat sketch, explain the working principle and advantages of vapour compression refrigeration system. (16)

Or

(b) It is required to design an air-conditioning plant for a small office room for following winter conditions:
Outdoor conditions - 14*ºC DBT* and 10ºC *WBT*
Required conditions - 20ºC *DBT* and 60% *R.H.*
Amount of air circulation - 0.30 m^3*/min./person.*
Seating capacity of office - 60.
The required condition is achieved first by heating and then by adiabatic humidifying.
Determine the following:
(i) Heating capacity of the coil in *kW* and the surface temperature required if the by-pass factor of coil is 0.4.
(ii) The capacity of the humidifier.
Solve the problem by using psychrometric chart. (16)

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