C 31711 (Pages : 2) Name.....

Reg. No.....

COMBINED FIRST AND SECOND SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, JUNE 2007

EE 04 108—MECHANICAL ENGINEERING—I

(2004 admissions)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

Part A

1. State Zeroth law of thermodynamics and explain how Zeroth law of thermodynamics forms the basis of temperature measurement.
2. Define internal energy and prove that it is a property of the system.
3. Define heat engine, refrigerator and heat pump.
4. What is the perpetual motion machine of the second kind ? An inventor claims to have developed a resistance heater that supplies 1.2 kWh of energy to a room for each kWh of electricity it consumes. Is this reasonable claim or has the inventor developed a perpetual-motion machine ? Explain.
5. Give an expression for air standard efficiency of the dual cycle. How does the cut off ratio (ρ) and explosion ratio (α) affect the efficiency of a dual cycle ?
6. Explain the Bell Coleman cycle of refrigeration with P-V and T-S diagram and state an expression for the COP of the cycle in terms of pressure ratio of the cycle.
7. Explain the fundamental difference between the operation of impulse and reaction steam turbines.
8. List and explain the advantages of multi-stage compression over the single stage compression in case of reciprocating compressors.

(8 × 5 = 40 marks)

Part B

1. The properties of a system during a reversible constant pressure non-flow process at P = 1.5 bar changed from $V_1 = 0.3\ m^3/kg$, $T_1 = 20^oC$, $V_2 = 0.55\ m^3/kg$, $T_2 = 2600$ C. The specific heat of the fluid is given by $C_p = (1.5 + 75/T + 45)\ kJ/kg^oC$; where T is in °C. Determine (i) Heat added / kg ; (ii) work done /kg ; (iii) change in internal energy/kg ; (iv) change in enthalpy/kg.

Or

2. The velocity and enthalpy of a fluid at the inlet of a certain nozzle are 200 m/sec and 3000 kJ/kg respectively. The enthalpy at the exit of the nozzle is 1500 kJ/kg. The nozzle is horizontal and adiabatic. Find
   (i) the velocity of the fluid at the exit of the nozzle ;
   (ii) mass flow rate if the inlet area is 0.2 m^2 and the specific volume is 0.25 m^3/kg ;
   (iii) exit area of nozzle if the specific volume at the exit of the nozzle is 0.9 m^3/kg.

Turn over

3. (a) State and prove the Carnot theorems. (7 marks)

(b) An inventor claims that his engine has the following specifications :

Temperature limits	—	727°C and 27°C.
Power developed	—	60 kW.
Fuel burned per hour	—	4 kg
Calorific value of the fuel	—	80,500 kJ/kg

State whether his claim is valid or not. (8 marks)

Or

4. A reversible heat engine operators between two reservoirs at temperature of 627°C and 47°C. The engine drives a reversible refrigerator, which operates, between reservoirs at temperature of 47°C and –20°C. The heat transfer to the heat engine is 2000 kJ. And the network output of the combined engine refrigerator plant is 360 kJ. (a) Evaluate the heat transfer to the refrigrant and the net heat transfer to the reservoir at 47°C. Reconsider (a) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values.

5. In an air standard diesel cycle, the compression ratio is 1.5. Compression begins at 1 bar, 30°C. The heat added is 1.750 MJ/kg. Find the maximum temperature and maximum pressure of the cycle, the thermal efficiency of the cycle and the mean effective pressure of the cycle.

Or

6. (a) With T-S diagrams, explain the various methods by which the thermal efficiency of a simple Rankine cycle can be improved.

(6 marks)

(b) With a flow diagram, explain the working of a vapour compression refrigeration cycle. Represent the cycle in T-S co-ordinates and derive an expression for the COP of the cycle.

(9 marks)

7. Briefly discuss about various renewable energy sources, the different methods of extracting energy from them and the recent tends and future scope of each.

Or

8. With a schematic layout, explain the working of a steam power plant. Discuss briefly the features of various subsystems of the power plant.

(4 × 15 = 60 marks]