CBCS Scheme

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15AU33

Third Semester B.E. Degree Examination, June/July 2018
Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: ***1. Answer any FIVE full questions, choosing one full question from each module.***
2. Use of thermodynamics data hand book is permitted.

Module-1

1 a. Differentiate between intensive and extensive property. State whether the following properties are intensive or extensive:
i) Refractive index of a glass slab ii) Velocity of a bullet
iii) Energy required to lift a container of water iv) Specific heat of gas. **(08 Marks)**

b. State and explain Zeroth law of thermodynamics. The temperature T on a thermometric scale is defined as $T = a \ln k + b$ where a and b are constants. The values of K are found to be 1.83 and 6.78 at 0°C and 100°C respectively. Calculate the temperature for a value of K = 2.42. **(08 Marks)**

OR

2 a. Define heat and work from thermodynamics view point and differentiate between them. Explain sign conventions for both. **(06 Marks)**

b. Classify the following as either heat or work interactions. The system to be considered is shown underlined.
i) Baking of Bread in a micro oven.
ii) Battery charger of a mobile phone getting heated.
iii) A rigid vessel containing steam at 100°C is left in the atmosphere at 30°C.
iv) A man drawing money from ATM counter. **(04 Marks)**

c. A non-flow reversible process occurs for which pressure and volume are correlated by the expression $p = V^2 + (8/V)$ where p is in bar and V is in m^3. Find the work done when volume changes from 3 m^3 to 6 m^3. **(06 Marks)**

Module-2

3 a. Starting from fundamentals, derive steady flow energy equation (SFEE). State the assumptions made. **(08 Marks)**

b. A small turbine runs an aircraft refrigeration system. Air enters the turbine at 4 bar and 40°C with a velocity of 40 m/s and leaves at 1 bar, 2.5°C with a velocity of 200 m/s. If the work output of the turbine is 50 kJ/kg of air find the heat transferred per kg of air. Take R = 0.287 kJ/kgK and C_p = 1.005 kJ/kg°C for air. **(08 Marks)**

OR

4 a. What are the limitations of first law of thermodynamics? With the help of schematic diagrams state and explain the second law of thermodynamics as per (i) Kelvin Plank (ii) Clausius. **(06 Marks)**

b. Define available and unavailable energy. **(04 Marks)**

c. Following results were collected from a heat engine supplied with 300 kJ/s of heat at 563 K.
(i) 220 kJ of heat rejected/s (ii) 150 kJ/s of heat rejected (iii) 75 kJ/s of heat rejected.
The heat rejection happened at 8.5°C. Find the change is entropy and state whether process is reversible or irreversible. **(06 Marks)**

Module-3

5 a. Define the following terms:
i) Air fuel ratio ii) Air standard efficiency
iii) Excess air iv) Brake thermal efficiency **(08 Marks)**

b. Show that the air standard efficiency of an engine working on ideal Otto cycle depends only on the compression ratio and not on the heat supplied to it. **(08 Marks)**

OR

6 a. An 8 cylinder, 4 stroke petrol engine of 90 mm bore and 80 mm stroke with a compression ratio of 7 at 4500 mm was tested on a dynamometer with 540 mm arm. During 10 min test, the dynamometer reading was 412 N and engine consumed 4.4 kg of petrol. Air at 27°C and 1 bar entered through the venturi at a rate of 6 kg/min. Assuming calorific value $CV_f = 44$ MJ/kg. find: (i) BP (ii) Brake mean effective pressure (iii) Brake thermal efficiency (iv) A:F ratio. **(08 Marks)**

b. During a trial on a six-cylinder petrol engine a Morse test was carried out as a means of estimating the IP of the engine. The measured BP when each cylinder was cut-out in turn and load reduced to bring the engine back to its original speed are as follows:

Cylinder Cut	1	2	3	4	5	6
Brake Power (KW)	42.5	41.6	41.8	42.0	42.4	41.9

From the above data determine: (i) The IP of the engine (ii) The mechanical efficiency when BP of 60 KW was developed at full load and with all cylinders firing. **(08 Marks)**

Module-4

7 a. Sketch and explain the working of a steam jet refrigeration system. **(08 Marks)**

b. A simple vapour compression plant produces 5 tons of refrigeration. The enthalpy values at the entry to the compressor, at the exit of compressor and at the exit of the condenser are respectively 184 kJ/kg, 210 kJ/kg and 75 kJ/kg. Estimate:
i) The refrigerant flow rate ii) COP
iii) Power required to run the compressor iv) Heat rejected to the atmosphere. **(08 Marks)**

OR

8 a. Define the following terms: (i) Specific humidity (ii) Wet bulb temperature (iii) Sensible cooling (iv) Degree of saturation **(08 Marks)**

b. If mixture of dry air and water vapour is at a temperature of 16°C. Find: (i) The saturation pressure of water vapour at 22°C (ii) Specific humidity (iii) Mass of water vapour and dry air (iv) Relative humidity (v) Saturation ratio **(08 Marks)**

Module-5

9 a. Define the isothermal and adiabatic efficiencies of a reciprocating compressor, showing the processes on a P-V or T-S diagram. **(05 Marks)**

b. What are the advantages of multi staging? Explain. **(05 Marks)**

c. Air at 1 bar and 25°C is compressed in a 2-stage air compressor according to the law $PV^{1.25} = C$, with complete intercooling to a pressure of 36 bar absolute. Estimate the minimum work required and the heat rejected in the intercooler per kg of air. Take $C_p = 1.05$ kJ/kgK, $R = 0.29$ kJ/kgK. Temperature after compression in cylinder = 427 K. **(06 Marks)**

OR

10 a. Classify gas turbines. With a neat sketch differentiate between a closed and an open cycle gas turbine. **(06 Marks)**

b. Explain with a neat sketch the principle of rocket propulsion. **(04 Marks)**

c. Determine the network output and the cycle efficiency of a simple gas turbine plant where air enters at 10 kPa and 27°C. The compression and expansion are ideal isentropic, with a pressure ratio of 9 and maximum cycle temperature limited to 727°C. Take $C_p = 1.005$ kJ/kgK. **(06 Marks)**