B.E. FTBE 2nd Yr. 2nd Sem. Examination 2017
THERMAL ENGINEERING

Time: Three hours | Full Marks: 100

Answer any ***five*** questions.
All parts of the same question must be answered at the same place.
Assume any relevant data if unfurnished.

Q.1

(a) Define 'heat' and 'work'. Discuss the similarities between them. **8**

(b) A gas, initially at 2 MPa, 300 ^0C, is contained in a frictionless piston-cylinder arrangement with an initial volume of 0.1 m^3. The gas is expanded in a quasi-static process according to the relation $PV^{1.4}$ = constant, until the final pressure of 200 kPa is reached. Determine the final volume of the gas and the work done during the process. **7**

(c) Find an expression for the work done by a system comprising an ideal gas during an isothermal process given by PV = constant in terms of P_1, V_1 and V_2. **5**

Q.2

(a) Write the first law of thermodynamics for the following cases:

(i) a closed system undergoing a change of state.

(ii) a control volume under steady steady state steady flow process. **8**

(b) A rigid tank contains 0.5 kg of steam at 90 ^0C with a dryness fraction of 0.4. Calculate the volume of the tank. **4**

(c) A mass of 0.3 kg of saturated water is completely vaporized at a constant pressure of 100 kPa in a piston-cylinder arrangement. Determine the volume change and the amount of heat added to the water. **8**

Q.3

(a) Plot the following processes for steam, identifying the saturation zone in each of the following cases.

(i) an isothermal process on *P-v* plane

(ii) a constant volume process on *T-s* plane

(iii) an isothermal process on *h-s* plane **6**

(b) Show how the slopes of wet steam and superheated steam will appear on the h-s plane and mathematically establish your answer. **8**

(c) How do you find the heat added for isobaric change of state for a closed system. **6**

Q.4

(a) Explain how the dryness fraction of relatively dry steam is measured. **10**

(b)The following observations are obtained from a combined separating and throttling calorimeter:

Pressure in the steam main = 0.8 MPa
Pressure after throttling = 0.1 MPa
Temperature after throttling = 110 ^0C

Mass collected in the separator in 5 minutes = 0.7 kg
Mass collected in the condenser in 5 minutes = 5.0 kg
Determine the dryness fraction of the steam in the main pipeline. **10**

Q.5

(a) Draw a neat sketch of a fire tube boiler and label different parts. **10**

(b) What are boiler mountings and accessories? Name two boiler mountings and two accessories, stating their functions. **10**

Q.6

(a) Draw the schematic diagram of a simple steam power plant and draw the Rankine cycle on T-s diagram. **10**

(b) Find the energy transfer rates across different components of the above plant in terms of specific enthalpy and mass flow rate of steam. Hence find the thermal efficiency of the Rankine cycle. **10**

Q.7

(a) Draw the schematic diagram of a steam power plant with one stage of reheating. Draw the corresponding cycle on *T-s* diagram.

Discuss the utility of reheating. **10**

(b) Discuss the effects of increasing the boiler pressure and decreasing the condenser pressure separately, on thermal efficiency, exit steam quality from the turbine for a simple Rankine cycle. 10

Table 1: Properties of saturated steam

T_{sat} (^0C)	P_{sat} (kPa)	v_f (m^3/kg)	v_g (m^3/kg)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kgK)	S_g (kJ/kgK)
90	70.13	0.0010361	2.3610	376.91	2660.0	1.1905	7.4789
99.62	100	0.0010432	1.6945	417.46	2675.4	1.3026	7.3595
170.44	800	0.0011149	0.2441	721.13	2769.1	2.0462	6.6628

Table 2: Properties of superheated steam (P=100 kPa)

T_{sup} (^0C)	v (m^3/kg)	h (kJ/kg)	u (kJ/kg)
100	1.69	2676	2507.0
150	1.94	2776	2583.0