B. TECH. (FTBE) Second Year Second Semester Examination 2024

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.
Use of property table is permitted.

Q.1

(a) Define: (i) system (ii) quasi-equilibrium process. **4**

(b) What is the difference between intensive property and extensive property? Give one example for both. **4**

(c) Define heat and work. **4**

(d) Consider as a system certain amount of gas in a piston-cylinder arrangement. The initial pressure of the gas is 200 kPa, and the initial volume is 0.04 m^3. A Bunsen burner is placed under the cylinder, and the volume of the gas increases to 0.1 m^3 while the pressure remains constant. Make a sketch, showing the system, boundary and surrounding. Plot the process on P-V diagram. Calculate the work done by the system during this process. **8**

Q.2

(a) Write the first law of thermodynamics for a closed system undergoing a thermodynamic cycle. Hence prove that the change of energy of the system during a change of state depends only on the end states and is independent of the process followed. **7**

(b) Show that for a stationary closed system undergoing a constant volume process, the heat transferred to the system may be expressed in terms of the change of internal energy of the system. **5**

(c) A rigid tank contains 0.5 kg of dry saturated steam at 100 ^{0}C. The steam is cooled to a final temperature of 80 ^{0}C. Find the (i) volume of the tank, (ii) the heat transferred during the process and the final pressure. Plot the process on *P*-v diagram. **8**

Q.3

(a) Explain how the dryness fraction of excessively wet steam is measured. **12**

(b) Wet steam at 1000 kPa flowing through a well-insulated pipeline is throttled to a pressure of 100 kPa and a temperature of 110 ^{0}C. Determine the condition of steam before the throttling process. Plot the process on *h-s* diagram. **8**

Q.4

(a) Draw the schematic diagram of a simple steam power plant and draw the Rankine cycle on *T-s* diagram. **8**

(b) Find the energy transfer rates across different components of the above plant. Hence find the thermal efficiency of the Rankine cycle. **8**

(c) For a simple Rankine cycle, what are the effects of increasing the boiler pressure on (i) the thermal efficiency and (ii) quality of exit steam from the turbine? Justify your answer. **4**

Q.5

(a) What is the primary reason for reheating in a modified Rankine cycle? What are the other benefits of reheating? **6**

(b) What is the primary reason for use of regenerative feed heating in a vapour power plant? Draw the schematic diagram of a steam power plant with one stage of regenerative feed heating. Draw the corresponding cycle on *T-s* diagram.. **14**

Q.6

(a) Discuss how a 4-stroke compression ignition engine works. **8**

(b) What is scavenging? How does it alter the power output and fuel efficiency of a spark ignition engine? **6**

(c) What is the utility of air standard cycle analysis? State the assumptions of air standard cycle analysis. **6**

Q.7

(a) What is a fire tube boiler and what is a water tube boiler? What are their fields of application? What are the functions of boiler mountings and boiler accessories? Name one boiler mounting and one accessory. **8**

(b) Draw a neat sketch of a water tube boiler and label its different parts. **12**