Code No: RT31035 **R13** SET - 1

III B. Tech I Semester Supplementary Examinations, Dec/Jan-2022-23

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Use of steam tables and Mollier chart is allowed)

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PART –A (22 Marks)

1. a) What are the advantages and disadvantages of liquid fuels? [3M]
   b) What are the boiler mountings and accessories? Write the basic difference between them. [4M]
   c) Explain the meta-stable flow in steam nozzles? [4M]
   d) What are the differences between impulse turbine and reaction turbine? [4M]
   e) How regeneration process improves the gas turbine cycle efficiency? Explain [4M]
   f) What is propulsive efficiency of a rocket engine? How it can be improved? [3M]

PART –B (48 Marks)

2. a) In a steam power cycle, steam at 20 bar, 350^{o}C is expanded to 0.1 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes, calculate per kg of steam the net work and cycle efficiency. [8M]
   b) Describe the working of a “Bomb Calorimeter” with the help of neat sketch. [8M]
3. a) Explain the construction and working of a “Babcock and Wilcox” boiler. [8M]
   b) Define chimney efficiency and derive an expression for the same. [8M]
4. a) A steam nozzle is supplied steam at 6 bar and 250^{o}C and it discharges steam at 1 bar. If the divergent portion of the nozzle is 64 mm long and the throat diameter is 5.6 mm, determine the cone angle of the divergent portion. Assume 12% of the total available enthalpy drop lost in friction in the divergent portion. Also determine the velocity and temperature of steam at throat. [8M]
   b) In a single row impulse turbine the nozzle angle is 25^{o} and the blade speed is 220 m/s. The steam speed is 540 m/s. The blade friction eco-efficient is 0.84. Assuming axial exit and a flow rate of 715 kg/hr, determine: [8M]
      (i) Blade angles,
      (ii) Absolute velocity of steam at exit, and
      (iii) The power output of the turbine.
5. a) In a 50-50 reaction turbine prove that $\alpha_1 = \beta_2$ and $\alpha_2 = \beta_1$. Where $\alpha$is the angle made by absolute velocity of steam with tangent of the wheel and β is the blade angle. Subscripts 1 and 2 indicate condition at inlet and outlet of the blade respectively. [8M]
   b) Describe the construction and working of Evaporative type of condenser with a neat sketch. [8M]

6. a) Explain effect of the following variables on thermal efficiency of a gas turbine power cycle: [8M]
   (i) Pressure ratio,
   (ii) Turbine inlet temperature,
   (iii) Compressor inlet temperature and
   (iv) Efficiency of the turbine.

   b) In a constant pressure open cycle gas turbine, air enters at 1.01325 bar and 24^{o}C. Air leaves the compressor at 6 bar, temperature of gases entering the turbine = 740^{o}C, pressure loss in the combustion chamber = 0.12 bar, Efficiency of compressor = 84%, Efficiency of turbine = 82%, Efficiency of combustion = 85%, γ_{air} = 1.4, C_p = 1.024 kJ/kgK for air and gas. [8M]
   Calculate:
   (i) The quantity of air circulation if the plant develops 1024 kW,
   (ii) Heat supplied per kg of air circulation,
   (iii) The thermal efficiency of the cycle.
   Mass of the fuel may be neglected.

7. a) Describe the construction and working of a turbo-prop engine. [8M]

   b) Describe the construction and working of a solid propellant rocket engine. State its advantages and disadvantages over liquid propellant rocket engine. [8M]