Code No : 20ME7T01 **R20**

IV B. TECH I SEMESTER REGULAR EXAMINATIONS NOVEMBER - 2023
APPLIED THERMODYNAMICS – II
(MECHANICAL ENGINEERING)

Time: 3 hours Max. Marks: 70

Note : Answer **ONE** question from each unit **(5 × 14 = 70 Marks)**

Steam Tables are allowed

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UNIT-I

1. a) A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550^{0}C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550^{0}C and expands through the low-pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagrams. Find: (i) quality of steam at turbine exhaust; (ii) cycle efficiency; (iii) steam rate in kg/kWh. [7M]

   b) Explain the classification of Boilers and Describe any one boiler with neat sketch [7M]

(OR)

2. a) In a single-heater regenerative cycle, the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.10 bar. The feed-water heater is a direct contact type which operates at 5 bar. Find (i) the efficiency and the steam rate of the cycle (ii) the increase in mean temperature of heat addition, efficiency, and steam rate as compared to the Rankine cycle (without regeneration). Pump work may be neglected. [8M]

   b) Explain the draught in boiler and differentiate the induced and forced draught. [6M]

UNIT-II

3. a) Steam enters a convergent-divergent nozzle at 2 MPa and 400°C with a negligible velocity and mass-flow rate of 2.5 kg/s and it exits at a pressure of 300 kPa. The flow is isentropic between the nozzle entrance and throat and overall nozzle efficiency is 93 percent. Determine (i) throat, and (ii) exit areas. [7M]

   b) The steam leaves the nozzles of a single-row impulse turbine at 900 m/s. The nozzle angle is 20^o and blade angles are 30^o at inlet and outlet. Calculate the blade velocity and work done per kg of steam. Assume the flow over the blade is frictionless. [7M]

(OR)

4. a) Explain the classification and working principle of a nozzle [6M]

   b) A single row impulse turbine develops 132.4 kW at a blade speed of 175 m/s, using 2 kg of steam per sec. Steam leaves the nozzle at 400 m/s. Velocity coefficient of the blades is 0.9. Steam leaves the turbine blades axially. Calculate nozzle angle, blade angles at entry and exit, assuming no shock. [8M]

UNIT-III

5. a) In a Parson reaction turbine, the angles of receiving tips are 35^o and of discharging tips, 20^o. The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency and axial thrust of the blade, if its steam consumption is 1 kg/min. [7M]
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b) 3000 kg of wet steam with a dryness fraction of 0.95 is condensed per hour in a barometric condenser. The minimum height of the tail race above the hot well is 8.5 m. The barometric pressure is 760 mm of Hg. The cooling water enters the condenser at 25°C and the mixture of condensate and cooling water exit temperature is 50°C. Calculate [7M]
(i) Vacuum in the condenser in mm of Hg,
(ii) Absolute pressure in the condenser in kPa,
(iii) Mass of cooling water required without under-cooling.

(OR)

6. a) In a reaction turbine, the diameter of the rotor is 2m and its speed is 840 rpm. The steam consumption amounts to 870 kg/min. The height of the blade at a particular stage is 15 cm. The exit angle of the nozzle and the moving blades is 25°. The pressure at this stage is 0.3 bar and steam is 0.98 dry. Estimate the power developed and the heat drop in kJ/s. [7M]

b) The vacuum gauge reading of a condenser is 71 cm of Hg and the mean temperature of the condenser is 35°C. The air leakage into the condenser is 1 kg per 2000 kg of steam. Determine the volume of air to be handled by the dry air pump per kg of steam and the mass of vapour associated with air. Barometer reading = 76 cm of Hg. [7M]

UNIT-IV

7. a) Explain the working of a gas turbine plant with reheating concept with a neat sketch and also draw the T-s and h-s diagrams. [7M]

b) A gas turbine unit receives air at 1 bar and 300K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of44,186 kJ/kg and the fuel-air ratio is 0.017 kg of fuel per kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air and thermal efficiency of cycle. Take for air C_p = 1.005 kJ/kg.K and γ = 1.4, and for product of combustion C_p = 1.147 kJ/kg.K and γ = 1.333. [7M]

(OR)

8. a) Explain the working of a closed cycle gas turbine with P-v & T-s plots. [6M]

b) A gas turbine unit has a pressure ratio of 6 and maximum cycle temperature of 610°C. The isentropic efficiency of the turbine and compressor are 0.82 and 0.8, respectively. Calculate the power output in kW of an electric generator, geared to the turbine, when air enters the compressors at 15°C at a rate of 16 kg/s. Take C_p = 1.005 kJ/kg. K and γ = 1.4 for compression process and C_p = 1.11 kJ/kg. K and γ = 1.333 for expansion process. [8M]

UNIT-V

9. a) A turbojet aircraft flies with a velocity of 300m/s at an altitude where the air is at 0.35 bar and -40°C.The compressor has a pressure ratio of 10, and the temperature of the gases at the turbine inlet is 1100°C.Air enters the compressor at a rate of 50kg/s. Estimate (i) the temperature and pressure of the gases at the turbine exit, (ii) the velocity of gases at the nozzle exit, and (iii) the propulsive efficiency of the cycle. [8M]

b) How a rocket propulsion system works? Explain. [6M]

(OR)

10. a) Explain the working of turbofan engine and mention its advantages. [7M]

b) Explain the solid propellant rocket with a neat sketch and list out its applications. [7M]

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