Code No: R2031031 **R20** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, December -2023
THERMAL ENGINEERING - II
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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UNIT-I

1. a) What are the various properties of fuel? Explain in detail. [7M]
   b) Explain the following boilers with their merits and applications: [7M]
   (i) Cornish boiler (ii) Lancashire boiler

(OR)

2. a) What is adiabatic flame temperature? How flame temperature can be calculated? [7M]
   b) A power generating plant uses stem as working fluid and operates at boiler pressure of 50bar, dry saturated and a condenser pressure of 0.1 bar. Calculate the following: i)The cycle efficiency; ii) The work ratio and specific steam consumption of Rankine cycle. Take pumping work also into account. [7M]

UNIT-II

3. a) What are the various methods of reducing wheel or rotor speed in steam turbines? [7M]
   b) A convergent-divergent nozzle is required to discharge 5 kg of steam per second. The nozzle is supplied with steam at 10bar and 200^0C and the discharge takes place against a back pressure of 0.34 bar. Estimate the throat and exit areas. Assume isentropic flow and take the index n=1.3. If the nozzle efficiency is assumed to be 85%, determine the exit area. [7M]

(OR)

4. a) Derive expression for critical pressure ratio for steam flow through nozzle. [7M]
   b) A steam turbine develops 180 kW, with a consumption of16 kg/kWh. The pressure and the temperature of the steam entering the nozzle are 11 bar and 200^0C. The steam leaves the nozzle at 1 bar. The diameter of the nozzle at the throat is 6.5 mm. Find the number of nozzles. If 7% of the total enthalpy drop is lost in friction in diverging part of the nozzle and exit velocity of the leaving steam. [7M]

UNIT-III

5. a) Show that reaction turbine blades are identical with each other for 50% reaction. [7M]
   b) During a trail on a steam condenser, the following observations were recorded. [7M]
   Condenser vacuum 680 mm Hg, barometer reading 764 mm Hg, mean temperature 36.2^0 C, hot well temperature 36^0 C, condensate formed per hour 1780 kg, circulating water inlet temperature 20^0 C, circulating cooling water outlet temperature 32^0 C and quantity of cooling water 1250 kg/min. calculate (i) mass of air present per kg of condensed steam (ii) condition of steam as it enters the condenser (iii) vacuum efficiency.

(OR)

6. a) The following data related to a stage of reaction turbine: mean rotor diameter 1.5 m, speed ratio 0.72, blade outlet angle 20^0 and rotor speed 3000 rpm. Determine: (i) the diagram efficiency, (ii) the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at best theoretical speed, the exit angle being 20^0. [7M]
   b) Explain the effects of air leakage in a steam condenser. [7M]

UNIT-IV

7. a) Differentiate the Rotary and Reciprocating compressors. [7M]
   b) Explain the significance of positive displacement compressor used to compress the air. [7M]

(OR)

8. a) Write a note on: [7M]
   i) Isothermal efficiency of reciprocating compressor
   ii) Volumetric efficiency of reciprocating compressor
   iii) Effect of clearance volume of reciprocating compressor
   b) Differentiate between positive displacement type compressors and dynamic compressors. [7M]

UNIT-V

9. a) Differentiate between centrifugal compressor and axial flow compressor. [7M]
   b) An axial flow compressor with compression ratio as 5, draws air at 20^0C delivers it at 50^0C. Assuming 50% degree of reaction, find the velocity of flow if the blade velocity is 100 m/s. Also find the number of stages if work factor = 0.85, $\alpha = 10^0$, $\beta = 40^0$ and Cp = 1.005 kJ/kg K. [7M]

(OR)

10. a) Define the term slip factor and power input factor with respect to the centrifugal compressor. Explain them. [7M]
    b) What is the role of impeller in the centrifugal compressor? Explain. [7M]

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UNIT-I

1. a) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and exhaust pressure is 0.2bar. Determine (i) Network output (ii) Rankine efficiency (iii) Dryness at the end of expansion, assume flow rate is 9.5 kg/s. [7M]
   b) Define chimney efficiency and derive an expression for the same. [7M]

(OR)

2. a) Explain the construction and working of a "Babcock and Wilcox" boiler [7M]
   b) Derive an expression for maximum discharge through the chimney for a given Height of chimney. [7M]

UNIT-II

3. a) What do you mean by compounding of steam turbines? List out various methods and discuss at least one method with neat sketch. [7M]
   b) A convergent divergent nozzle is to be designed in which steam initially at 14 bar and 80^0 C of superheat is to be expanded down to a backpressure of 1.05 bar. Determine the necessary throat and exit diameter of the nozzle for steam discharge of 500 kg/hr, assuming that the expansion is in thermal equilibrium throughout and friction reheat amounting to 12% of total isentropic enthalpy drop to be effective in the divergent part of the nozzle. [7M]

(OR)

4. a) Explain the functions of the convergent portion, the throat and the divergent portion of a convergent-divergent nozzle with reference to flow of steam. [7M]
   b) The following data related to a stage of reaction turbine: mean rotor diameter 1.5 m, speed ratio 0.72, blade outlet angle 20^0 and rotor speed 3000 rpm. Determine: (i) the diagram efficiency, (ii) the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at best theoretical speed, the exit angle being 20^0. [7M]

UNIT-III

5. a) What is the fundamental difference between the operation of impulse and reaction turbines? Explain the same with neat sketches. [7M]
   b) The vacuum at the bottom of a surface condenser is 65.4 cm of mercury (barometer 75.7 cm), the temperature at the air pump suction is 36.2^0C. If the rate of air leakage into the condenser is 1 kg per 1000 kg of steam, estimate the mass of air and vapour removed by the air pump per minute when the engine consumption is 136000 kg of steam/hr. [7M]

(OR)

6. a) Derive an expression for maximum efficiency of reaction turbine. [7M]
   b) Distinguish between jet condensers and surface condensers. [7M]

UNIT-IV

7. a) Discuss about the classification of compressors. [7M]
   b) With the help of neat sketches explain a roots air blower. How its PV diagram is different from a reciprocating air compressor [7M]

(OR)

8. a) Derive the expression for the volumetric efficiency of a reciprocating air compressor in terms of clearance ratio, pressure ratio and index of the compression. [7M]

   b) A single stage single acting reciprocating air compressor running at 900 rpm delivers air at 12 bar. The induction and free air conditions can be taken as 1 bar and 300 K and the free air delivery as 0.5 m^3/min. Calculate the bore and stroke, the volumetric efficiency, the indicated power and the isothermal efficiency. Assume the index of compression and expansion is 1.3. [7M]

UNIT-V

9. a) Explain and neat sketch of centrifugal compressor in detail. [7M]

   b) Write down the mechanical details and principles of axial flow compressors. [7M]

(OR)

10. a) Explain, with a neat sketch the working of an axial flow compressor. [7M]

    b) What are different losses occurring in the centrifugal compressor due to different blade shapes? Explain. [7M]

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UNIT-I

1. a) With neat sketch explain the methods to improving the performance of Rankine cycle? [7M]
   b) Explain working principle of boilers and classify various types of boilers? [7M]

(OR)

2. a) What is the Draught? Write down the difference between Induced and forced draught? [7M]
   b) In a regenerative cycle the inlet conditions are 40 bar and 400°C. Steam is bled at 10 bar in regenerative heating. The exit pressure is 0.9 bar. Neglecting pump work, determine the efficiency of the cycle. [7M]

UNIT-II

3. a) What are the effects of super saturated flow? [7M]
   b) Steam from nozzle enters into a single stage impulse turbine at 350 m/s absolute velocity. The nozzle angle=25°. The blade rotor mean diameter is 100cm and rotating at a speed of 2000 rpm. Find the blade angles if the axial thrust is zero. Find the power developed when the steam flow rate is 500 kg/min. Take blade velocity coefficient=0.9. [7M]

(OR)

4. a) What are the methods to reduce rotor speed in De-laval turbine and explain [7M]
   b) Write a short note on [7M]
      I. Power developed
      II. Effect of friction and
      III. Blade efficiency of Impulse turbine

UNIT-III

5. a) Draw the velocity diagram of a reaction turbine and derive the expression for the degree of reaction on the blade. [7M]
   b) Enlist the various steam condensers and explain any two of them? [7M]

(OR)

6. a) What is working principle of steam condenser and what are the requirements of steam condensing plant. [7M]
   b) Explain the conditions for maximum efficiency in Parson's reaction turbine. [7M]

UNIT-IV

7. a) What are the differences between positive and non-positive displacement types? [7M]
   b) Classify compressor and write their advantages and disadvantages. [7M]

(OR)

8. a) Explain working principle of reciprocating compressor. [7M]
   b) Explain efficiency considerations for Lysholm compressor. [7M]

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UNIT-V

9. a) Explain the working of centrifugal compressor and their function. [7M]
   b) Explain velocity diagrams with neat sketch for centrifugal compressor. [7M]

(OR)

10. a) Explain mechanical details of axial flow compressor. [7M]
    b) What is work done factor, isentropic efficiency and polytropic efficiency in axial flow compressor? [7M]

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*****

UNIT-I

1. a) Give the comparison for Fire tube boiler and Water tube boiler. [7M]
   b) Steam is generated at 100000kg/hr from a boiler at 150 bar, 500°C with feed water supplied at 150°C. The fuel burnt in boiler has calorific value of 23000kJ/kg and boiler efficiency is 80%. Determine the rate of fuel burnt per hour and percentage of total heat absorbed in economizer [7M]

(OR)

2. a) What is the function of steam generator? Enlist its basic components. [7M]
   b) What are the essentials of a good steam boiler? Estimate the factors which should be considered while selecting a boiler. [7M]

UNIT-II

3. a) Write the classification of steam turbines in detail. [7M]
   b) Steam initially dry and saturated is expanded in a nozzle from 15 bar at 350°C to 1.0 bar. If the frictional loss in the nozzle is 10 % of the total heat drop. Calculate the mass of steam discharged when exit diameter of the nozzle is 15 mm. [7M]

(OR)

4. a) How does a steam turbine convert energy in steam to shaft work? And explain the effect of friction? [7M]
   b) What do you mean by compounding of steam turbine? Discuss various methods of compounding steam turbines. [7M]

UNIT-III

5. a) What are the effects of air leakage on the performance of a condenser? Explain [7M]
   b) Explain principle of operation of reaction turbine with neat sketch. [7M]

(OR)

6. a) What are types of steam condenser? Explain briefly [7M]
   b) Discuss briefly about air leakage source and its affects and cooling water requirement of steam condenser. [7M]

UNIT-IV

7. a) Obtain the volumetric efficiency of multi stage reciprocating compressor with clearance volume. [7M]
   b) Explain the types of non-positive displacement compressors with neat sketches. [7M]

(OR)

8. a) A double acting single cylinder reciprocating air compressor has a piston displacement of 0.02 cubic metre per revolution operates at 450 rpm and has a 5% clearance. The air is received at 1 bar and delivered at 6 bar. The compression and expansion are polytropic with n=1.3. Determine a) Volumetric efficiency b) Power required [7M]
   b) Compare the reciprocating compressor with rotary compressor. [7M]

|'''|'|'|''||'''||||

UNIT-V

9. a) Describe the working of centrifugal compressor. [7M]
   b) An axial flow compressor with compression ratio as 5, draws air at 20^0C delivers it at60^0C. Assuming 50% degree of reaction, find the velocity of flow if the blade velocity is 150 m/s. Also find the number of stages if work factor = 0.85, $\alpha = 10^0$, $\beta = 40^0$ and Cp = 1.005 kJ/kg K. [7M]

(OR)

10. a) An axial flow compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.9 when the air inlet temperature is 40°C. The blade speed and axial velocity are constant throughout the compressor. Assuming a value of 200m/s for the blade speed, find the number of stages required when the work factor is unity [7M]
    b) What are different losses occurring in the centrifugal compressor due to different blade shapes? Explain concept of slip factor? [7M]