Printed Page:- Subject Code:- BME0303

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - THEORY EXAMINATION (20..... - 20.....)

Subject: Engineering Thermodynamics

Time: 3 Hours Max. Marks: 100

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. This Question paper comprises of three Sections -A, B, & C. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A 20

1. Attempt all parts:-

1-a. Which one of the following is the extensive property of a thermodynamic system? (CO1,K1) 1

(a) Volume

(b) Pressure

(c) Temperature

(d) Density

1-b. A closed thermodynamic system is one in which (CO1, K1) 1

(a) There is no energy or mass transfer across the boundary

(b) There is no mass transfer, but energy transfer exists

(c) There is no energy transfer, but mass transfer exists

(d) Both energy and mass transfer take place across the boundary, but the mass transfer is controlled by valves

1-c. Which of the following is the correct criteria for a spontaneous process? (CO2, K1) 1

(a) $\Delta S_{system} - \Delta S_{surroundings} > 0$

(b) $\Delta S_{surroundings} > 0$ only

(c) $\Delta S_{system} + \Delta S_{surroundings} > 0$

(d) $\Delta S_{system} > 0$ only

1-d. What is the unit of entropy? (CO2, K1) 1

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(a) J mol-1
(b) J K mol-1
(c) J-1 K-1 mol-1
(d) J K-1 mol-1

1-e. To maximize the work output at turbine, the specific volume of working fluid should be (CO3, K1) 1

(a) as small as possible
(b) as large as possible
(c) constant throughout the cycle
(d) none of the above

1-f. Sometimes the pump work in vapour power cycle is neglected because (CO3, K1) 1

(a) the pump work in not considered in efficiency of vapour power cycle
(b) the pump work is very small compared to the heat addition
(c) the pump work is very small compared to the turbine work
(d) none of the above

1-g. Which of the following boiler is best suited to meet the fluctuating demand of steam? (CO4, K1) 1

(a) Locomotive boiler
(b) Lancashire boiler
(c) Cornish boiler
(d) Babcock and wilcox boiler

1-h. Which of the following is a water tube boiler? (CO4, K1) 1

(a) Locomotive boiler
(b) Lancashire boiler
(c) Cornish boiler
(d) Babcock and wilcox boiler

1-i. A steam turbine with no nozzle is _____. (CO5, K1) 1

(a) Reaction turbine
(b) Impulse turbine
(c) Both of these
(d) None of these

1-j. The governing principle of steam turbines are_____. (CO5, K1) 1

(a) Nozzle control governing
(b) Throttle governing
(c) Bypass governing
(d) All of the above

2. Attempt all parts:-

2.a. What is a quasi-static process? (CO1, K1) 2

2.b. Explain heat engine. (CO2, K2) 2

2.c. Draw P-v, T-s diagram of Rankine cycle. (CO3, K2) 2

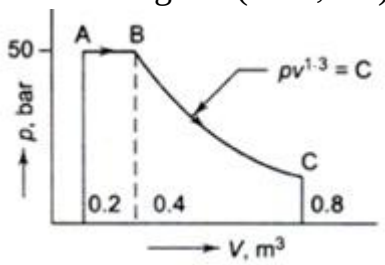
2.d. Define effectiveness of a regenerator. (CO4, K1) 2

2.e. Explain the principle of operation of steam turbine. (CO5, K2) 2

SECTION-B 30

3. Answer any five of the following:-

3-a. Determine the total work done by a gas system following an expansion process as shown in Figure. (CO1, K3) 6



3-b. Write down the general energy equation for steady flow system and simplify when applied for the following systems : a) Pump b) Condenser c) Turbine. (CO1, K3) 6

3-c. State the significance of heat engine. Determine the heat to be supplied to a Carnot engine operating between 400ºC and 15ºC and producing 200 kJ of work. (CO2, K3) 6

3-d. State the significance of refrigerator. A refrigerator operates on reversed Carnot cycle. Determine the power required to drive refrigerator between temperatures of 42ºC and 4ºC if heat at the rate of 2 kJ/s is extracted from the low temperature region. (CO2, K3) 6

3.e. Describe reheat cycle and compare it with simple Rankine cycle. (CO3, K3) 6

3.f. What is the significance of a boiler? Differentiate between fire tube and water tube boilers. (CO4, K2) 6

3.g. Define nozzle and state its classification with a neat sketch. (CO5, K2) 6

SECTION-C 50

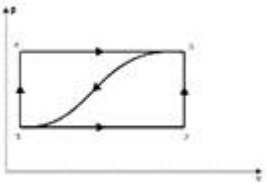
4. Answer any one of the following:-

4-a. A fluid system, contained in a piston and cylinder machine, passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is – 340 kJ. The system completes 200 cycles per min. Complete the following table showing the method for each item, and compute the net rate of work output in kW. (CO1, K3) 10

Process	*Q (kJ/min)*	*W (kJ/min)*	*ΔE (kJ/min)*
1—2	*0*	*4340*	—
2—3	*42000*	*0*	—
3—4	*- 4200*	—	*- 73200*
4—1	—	—	—

4-b. When a system is taken from state 1 to state 3, in Figure, along path 143, 168 kJ of 10

heat flows into the system, and the system does 64 kJ of work : (i) How much will be the heat that flows into the system along path 123 if the work done is 21 kJ ? (ii) When the system is returned from 3 to 1 along the curved path, the work done on the system is 42 kJ. Does the system absorb or liberate heat, and how much of the heat is absorbed or liberated ? (iii) If $U_1 = 0$ and $U_2 = 84$ kJ, find the heat absorbed in the processes 12 and 23. (CO1, K3)



5. Answer any <u>one</u> of the following:-

5-a. Derive the expression for efficiency of heat engine. A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine : (i) The thermal efficiency ; (ii) The rate of heat rejection. (CO2, K3) 10

5-b. Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find (a) The intermediate temperature between A and B (b) The efficiency of each engine (c) The heat rejected to the cold sink. (CO2, K3) 10

6. Answer any <u>one</u> of the following:-

6-a. In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: i) The pump work ii) Turbine work iii) Rankine efficiency iv) Condenser heat flow v) Dryness at the end of expansion. Assume flow rate of 9.5 kg/s. (CO3, K3) 10

6-b. Give limitations of Carnot vapour power cycle and explain how Rankine cycle helps in overcoming them. Discuss the limitations of maximum and minimum temperatures in a steam power cycle. (CO3, K3) 10

7. Answer any <u>one</u> of the following:-

7-a. What are boiler accessories? State the location and function of the following devices: i) Air preheater ii) Economiser iii) Blow off valve iv) Superheater. (CO4, K2) 10

7-b. Consider a Brayton cycle in which the air enters the compressor at 1.0 bar and 20°C. The pressure of air leaving the compressor is 3.5 bar and the temperature at turbine inlet is 600°C. Determine per kg of air : (i) Efficiency of the cycle, (ii) Heat supplied to air, (iii) Work available at the shaft, (iv) Heat rejected in the cooler, and
(v) Temperature of air leaving the turbine. For air $\gamma = 1.4$ and cp = 1.005 kJ/kg K. (CO4, K3) 10

8. Answer any <u>one</u> of the following:-

8-a. Define critical pressure ratio for nozzle of steam turbine. Obtain an expression for it in terms of adiabatic constant. (CO5, K3) 10

8-b. Explain Pressure-Velocity Compounded impulse turbine with neat sketch. Also state its advantages. (CO5, K3) 10

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