PAPER ID-411850

Roll No: | | | | | | | | | | | | |

BTECH
(SEM III) THEORY EXAMINATION 2021-22
THERMODYNAMICS

Time: 3 Hours *Total Marks: 100*

Note: Attempt all Sections. If require any missing data; then choose suitably.
Use of steam tables and mollier chart is allowed.

SECTION A

1. **Attempt *all* questions in brief.** **2 x 10 = 20**

a.	Differentiate between macroscopic and microscopic properties.
b.	Explain the Clausius statement of second law of thermodynamics.
c.	Explain quasi-static process.
d.	Define steady and unsteady flow.
e.	Discuss the causes of irreversibility.
f.	List the limitations of first law of thermodynamics.
g.	Differentiate between a refrigerator and a heat pump.
h.	Derive the relationship between COP of heat pump and refrigerator.
i.	Define thermodynamic equilibrium.
j.	Define Brake power and Indicated power of an I C Engine.

SECTION B

2. **Attempt any *three* of the following:** **10x3=30**

a.	Define displacement work. A frictionless piston-cylinder device contains 5 kg of steam at 400kPa and 200ºC. Heat is transferred to steam until the temperature reaches 250ºC. If the piston is not attached to the shaft and its mass is constant, determine the work done by steam during this process.
b.	A Carnot refrigeration cycle is executed in a closed system in the saturated liquid vapour mixture region using 0.8kg of refrigerant- 134a as working fluid. The maximum and the minimum temperatures in the cycle are 20ºC and 8ºC, respectively. It is known that the refrigerant is saturated liquid at the end of the heat rejection process, and the net work input to the cycle is 15kJ. Determine the fraction of the mass of the refrigerant that vaporizes during the heat addition process and the pressure at the end of the heat rejection process.
c.	Air is compressed from an initial state of 100kPa and 17ºC to a final state of 600kPa and 57ºC. Determine the entropy change of air during this compression process by using $c_{p(air)}$ = 1.005kJ/kgK.
d.	A 50 kg iron block at 80ºC is dropped into an insulated tank that contains 0.5 m³ of liquid water at 25ºC. Determine the temperature when thermal equilibrium is reached.
e.	Define availability. Derive the expression for availability of closed system.

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SECTION C

3. **Attempt any *one* part of the following:** **10x1=10**

a.	Air at 100kPa and 280K is compressed steadily to 600kPa and 400K. The mass flow rate of the air is 0.02 kg/s, and a heat loss of 16kJ/kg occurs during the process. Assuming the changes in kinetic and potential energies are negligible, determine the necessary power input to the compressor.
b.	A quantity of air undergoes a thermodynamic cycle consisting of three processes. Process 1-2: Constant volume heating from P_1 = 0.1 MPa, T_1 = 15°C, V_1 = 0.02 m^3 to P_2 = 0.42 MPa. Process 2-3: Constant pressure cooling. Process 3-1: Isothermal heating to initial state. Employing the ideal gas model with C_p = 1 kJ/kgK, evaluate the change of entropy for each process. Sketch the cycle on p-v and T-s coordinates.

4. **Attempt any *one* part of the following:** **10x1=10**

a.	Consider a steam power plant operating on a simple ideal Rankine cycle. Steam enters the turbine at 3MPa and 350ºC and is condensed in the condenser at a pressure of 75kPa. Determine the thermal efficiency of this cycle.
b.	Wet steam at 20 bar pressure and 0.9 dryness fraction is heated reversibly at constant pressure to a temperature of 300°C. Make calculations for the work done, heat supplied and changes in internal energy and entropy. Represent the process on T-s diagram and indicate there upon the area which represents the heat interaction.

5. **Attempt any *one* part of the following:** **10x1=10**

a.	Discuss the concept of internal energy. A fluid is confined in a cylinder by a spring loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (p= a +bv). The internal energy of the fluid is given by the following equation: $$U = 34 + 3.15pV$$ Where U is in kJ, p in kPa and V in cubic metre. If the fluid changes from an initial state of 170kPa, 0.03m^3 to a final state of 400kPa, 0.06 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.
b.	Demonstrate Carnot theorem. An engine manufacturer claims to have developed a heat engine with the following specifications: Power developed: 75kW, fuel burnt: 5kJ/hr, heating value of fuel: 75000kJ/kg, temperature limits: 1000K and 400K. Is the claim of the manufacturer true or false? Give reasons for your answer.

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6. **Attempt any *one* part of the following:** 10x1=10

a.	Three reversible engines of Carnot type are operating in series between temperatures of 1100K and 300K as shown in figure. Determine the intermediate temperature if the work output from engines is in the proportion of 3:2:1.
b.	Illustrate the equivalence of the two statements of second law of thermodynamics.

7. **Attempt any *one* part of the following:** 10x1=10

a.	Explain the construction and working of a four stroke C.I. Engine. Also discuss the concept of heat balance sheet of IC engines.
b.	Briefly explain the terms: Mean effective pressure, Mechanical Efficiency, Brake thermal efficiency, Indicated thermal efficiency, Brake specific fuel consumption.