



SE-6869

B. E. III (Sem. V) (Mechanical) Examination

April / May - 2011

Thermodynamics - II

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

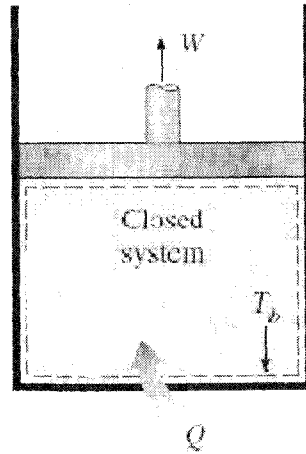
नीचे दशांशिक निशानीवाणी विगतो उत्तरवही पर अवश्य लખवी. Fillup strictly the details of signs on your answer book.		Seat No. :	
Name of the Examination :		<input type="text"/>	
← B. E. III (SEM. V) (Mechanical)		<input type="text"/>	
Name of the Subject :		<input type="text"/>	
← Thermodynamics - 2		<input type="text"/>	
← Subject Code No. :		← Section No. (1, 2,.....) :	
6 8 6 9		Nil	
		Student's Signature	

- (2) Answer all questions.
- (3) Figures to the right indicate full marks.
- (4) Give justifying assumptions, wherever necessary.
- (5) Use of steam tables, mollier diagram, refrigeration charts, compressibility chart are permitted.
- (6) Use of non programmable scientific calculator is permitted.

1 (a) Answer the following : 10

- (1) Can a process for which the reversible work is zero be reversible ? Can it be irreversible ? – Explain.
- (2) What does the dew point temperature of the product gas represent ? How is it determined ?
- (3) What does it imply if the compressibility factor is larger than 1 ?
- (4) Is energy transfer as work 100% available ? Justify your answer.
- (5) Does the Clapeyron equation involve any approximation, or is it exact.

- (b) Starting with energy and entropy balances, derive the general exergy balance relation for a closed system shown in Fig. 10



- 2 (a) Consider a gas mixture that consists of 3 kg of O_2 , 5 kg of N_2 and 12 kg of CH_4 . Determine (a) the mass fraction of each component, (b) the mole fraction of each component, and (c) the average molar mass and gas constant of the mixture. 7

OR

- (a) Derive four Maxwell's relations from Gibbs relations. 7
- (b) A 200-m^3 rigid tank contains compressed air at 1 MPa and 300 K. Determine how much work can be obtained from this air if the environment conditions are 100 kPa and 300 K. 8
- 3 (a) A piston-cylinder device contains 0.05 kg of steam at 1 MPa and 300°C . Steam now expands to a final state of 200 kPa and 150°C , doing work. Heat losses from the system to the surroundings are estimated to be 2 kJ during this process. 10

Assuming the surroundings to be at $T_0 = 25^\circ\text{C}$ and

$P_0 = 100\text{ kPa}$, determine (a) the exergy of the steam at the initial and the final states, (b) the exergy change of the steam, (c) the exergy destroyed, and (d) the second-law efficiency for the process.

- (b) Gaseous propane mixes with air, both supplied at 500 K, 0.1 MPa. The mixture goes into a combustion chamber and products of combustion exit at 1300 K, 0.1 MPa. The products analyzed on a dry basis are 11.42% CO₂, 0.79% CO, 2.68% O₂, and 85.11% N₂ on a volume basis. Find the equivalence ratio. 5

OR

- (b) Why are products measured on a dry basis ? 5

4 Answer the following : 10

- (1) Define propulsive power.
- (2) Define refrigerating effect.
- (3) Define dry compression.
- (4) Define cycle.
- (5) Define one tone of refrigeration.
- (6) Write a function of rectifier.
- (7) The optimum reheat pressure the most of the modern vapour power plant is about _____ to _____ of initial pressure.
- (8) The heating of feed water by steam 'bled' from the turbine, known as regeneration, _____ the Rankine cycle.
- (9) _____ lead has been added the rising the octane number.
- (10) For the same compression ratio and same heat rejection, the efficiency of Diesel cycle is _____ the efficiency of Otto cycle.

5 Answer any four : 16

- (a) Compare Rankine cycle and Carnot cycle.
- (b) Explain with neat sketch ideal reheat Rankine cycle.
- (c) Show that the efficiency of Brayton cycle depends only on pressure ratio also draws P-v and T-s diagrams.
- (d) Explain in brief flash chamber. Also write its advantage.
- (e) Explain in brief Lithium Bromide Water Absorption Refrigeration Plant with figure.

- (a) Consider a steam power plant that operates on an ideal reheat regenerative Rankine cycle with one open water feed water heater, one closed feed water heater and one reheater. Steam enters the turbine at 15 Mpa and 600°C and is condensed in the condenser at a pressure of 10 kPa. Some steam is extracted from the turbine at 4 Mpa for the closed feed water heater and the remaining steam is reheated at the same pressure to 600°C. The extracted steam is completely condensed in the heater and is pumped to 15 Mpa before it mixes with the feed water at the same pressure. Steam for the open water feed heater is extracted from the low pressure turbine at a pressure of 0.5 Mpa. Determine the fractions of steam extracted from the turbine as well as the thermal efficiency of the cycle. Sketch a line diagram of the arrangement of the plant and sketch on the T-s diagram all the processes.
- (b) An ideal Otto cycle has a compressor ratio of 8. At the beginning of the compression process, air is at 100 kPa and 17°C and 800 kJ/kg of heat is transferred to air during the constant volume heat addition process. According for the variation of specific heats of air with temperature, determine (a) the maximum temperature and pressure that occur during the cycle, (b) the net work output, (c) the thermal efficiency and (d) the mean effective pressure for the cycle. $C_v = 0.709 + 0.000028 T$ kJ/kg K and $R = 0.287$ kJ/kg K.
- (c) A stationary power plant operating on an ideal Brayton cycle has a pressure ratio of 8. The gas temperature is 300 K at the compressor inlet and 1300 K at the turbine inlet. Utilizing the air standard assumptions, determine (a) the gas temperature at the exits of the compressor and the turbine, (b) the back work ratio and (c) the thermal efficiency.
- (d) In an aqua ammonia absorption refrigerator system, heat is supplied to the generator by condensing steam at 0.2 MPa, 90% quality. The temperature to be maintained in the refrigerator is -10°C and the ambient temperature is 30°C. Estimate the maximum COP of the refrigerator.
- If the actual COP is 40% of the maximum COP and the refrigerator load is 20 tonnes, what will the required steam flow rate be ?