



RN-6869

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

May / June - 2010

Thermodynamics - II

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दृष्टावेक निशानीवाणी विगतो उत्तरवडी पर अवश्य लखवी.
Fillup strictly the details of signs on your answer book.

Name of the Examination :
B. E. 3 (Sem. 5) (Mechanical)

Name of the Subject :
Thermodynamics - 2

Subject Code No. : **6 8 6 9** Section No. (1, 2,.....): **1&2**

Seat No. :

Student's Signature

- (2) Answer all questions.
(3) Use separate answer books for each section.
(4) Figures to the right indicate full marks.
(5) Assume suitable data, if necessary.
(6) Use of steam table, mollier diagram, refrigeration charts are permitted.

SECTION-I

- 1 (a) Why exergy of a fluid at higher temperature is more than that at a lower temperature? **10**
(b) What do you understand by dead state?
(c) What is inversion temperature?
(d) What is adiabatic flame temperature and its significance?
(e) What are reduced properties?
- 2 (a) Steam enters a turbine steadily at 3 MPa and 450°C at a rate of 8 kg/s and **10** exits at 0.2 MPa and 150°C, The steam is losing heat to the surrounding air at 100 kPa and 25°C at a rate of 300 kW, and the kinetic and potential energy changes are negligible. Determine (a) the actual power output,(b) the maximum possible power output, (c) the second-law efficiency, (d) the exergy destroyed, and (e) the exergy of the steam at the inlet conditions.

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- (a) (i) A system at 400 K receives 150 kJ/s of heat from a source at 1200 K. Atmospheric temperature is 300 K. In case the temperatures of both the systems and source are assumed to be constant during heat transfer process, find the net change in entropy, available energy of heat source and the system and the decrease in available energy. 07
- (ii) Show that for a perfect gas the Joule-Thomson coefficient is equal to zero. 03
- 3 Attempt any three** 30
- (a) Liquid octane (C_8H_{18}) enters the combustion chamber of a gas turbine steadily at 1 atm and 25°C, and it is burned with air that enters the combustion chamber at the same state. Determine the adiabatic flame temperature for complete combustion with 400 percent theoretical air.
- (b) Ethane (C_2H_6) is burned with 20 percent excess air during a combustion process. Assuming complete combustion and a total pressure of 100 kPa, determine (a) the air-fuel ratio and (b) the dew-point temperature of the products.
- (c) Derive any two Maxwell relations
- (d) What is compressibility factor and enthalpy departure?

SECTION II

- Q.4 Answer the following:** (10)
- A) The given statement is true or false. "For the same temperature of source and sink the thermal efficiency of Carnot cycle is equal to that of the Stirling cycle".
- B) Efficiency of Diesel cycle increase as cut-off ratio becomes _____.
- C) An isentropic process on T – S diagram is represented by a _____ line.
- D) Define ton of refrigeration.
- E) Write a function of Analyzer.
- F) Draw P – v & T – s diagram of the Stirling cycle.
- G) In Rankine cycle consists of two _____ and _____ process.
- H) Define dry compression.
- I) Define steam rate.
- J) Define cogeneration.
- Q.5 Answer any Two:** (10)
- A) Define the cut-off ratio in the diesel engine. Write down the expression for the efficiency when the cut-off ratio is expressed as percentage of stroke volume.

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- B) Explain with neat sketch ideal regenerative Rankine cycle with closed feed water heater.
- C) Explain in brief multistage compression refrigeration systems.

Q.6 Answer any Three:

(30)

- A) Consider a steam power plant operating on the ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350 °C and is condensed in the condenser at a pressure of 10 kPa. Determine (a) the thermal efficiency of the power plant, (b) the thermal efficiency if steam is superheated to 600 °C, (c) the thermal efficiency if the boiler pressure is raised to 15 Mpa while the turbine inlet temperature is maintained at 600 °C, (d) sketch a line diagram of the arrangement of the plant and (e) sketch on the T – s diagram all the processes.
- B) An air standard dual cycle has a compression ratio of 16 and compression begins at 1 bar & 50 °C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate (a) the pressure and temperature at the cardinal points of the cycle, (b) the cycle efficiency and (c) the mean effective pressure of the cycle, $C_v = 0.718 \text{ kJ/kg K}$, $C_p = 1.005 \text{ kJ/kg K}$.
- C) In an ideal brayton cycle air from the atmosphere at 1 atm, 300 K is compressed to 6 atm and the maximum cycle temperature is limited to 1100 K by using a large air fuel ratio. If the heat supply is 100 MW, find (a) the thermal efficiency of the cycle, (b) work ratio, (c) power output and (d) exergy flow rate of the exhaust gas leaving the turbine.
- D) A refrigerant R – 12 vapour compression plant producing 10 tonnes of refrigeration operates with condensing and evaporating temperature of 35 °C and - 10 °C respectively. A suction line heat exchanger is used to subcool the saturated liquid leaving the condenser. Saturated vapour leaving the evaporator is superheated in a suction line heat exchanger to the extent that a discharge temperature of 60 °C is obtained after isentropic compression. Determine (a) the subcooling achieved in the heat exchanger, (b) the refrigerant flow rate in kg/s, (c) the cylinder dimensions of the two cylinder compressor, if the speed is 900 rpm, stroke to bore ratio is 1.1 and the volumetric efficiency is 80 %, (d) the COP of the plant and (e) the power required to drive the compressor in kW.