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Printed Pages – 4 **TME – 302**

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4069 **Roll No.** | | | | | | | | | | |

B.Tech.

THIRD SEMESTER EXAMINATION, 2005-2006

APPLIED THERMODYNAMICS

Time : 3 Hours *Total Marks : 100*

Note : *(i) Attempt **ALL** questions.*
(ii) All questions carry equal marks.
(iii) Assume missing data suitably, if any.
(iv) Use of Steam Table/Mollier's chart is permissible.
(v) Be precise in your answer.

1. Attempt ***any four*** of the following questions : **(5x4=20)**
   (a) Define Gibb's and Helmholtz function and then derive Maxwell Relations.
   (b) Discuss Joule-Thompson Coefficient and inversion curve.
   (c) 5 kg of Air is heated reversibly at constant pressure of 1.5 bar from 27°C to 227°C. If the lowest available temperature is 20°C determine the increase in the available energy of air due to heating. Take c_p of air as 1005 J/kg.K.
   (d) An electric motor of 1 kW rating is used for driving heat pump which supplies heat to a building for maintaining it at 26°C. Heat loss from building to the surrounding due to temperature difference is 6 MJ/hr. Discuss whether the motor is capable of maintaining

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the desired temperature on some day when the surrounding temperature is 3°C. State your assumptions.

(e) Define : (i) Availability, (ii) Dead state. Determine the available and unavailable energy of a heat source of 1000 kJ at 1073 K. The lowest possible temperature is 20°C.

(f) State the Clapeyron equation and discuss its' importance during phase change of pure substance.

2. Attempt *any two* of the following questions : **(10x2=20)**

(a) What are various boiler mountings ? Discuss any two of them in brief along with their sketch. Also differentiate boiler mountings with boiler accessories.

(b) (i) Compare water tube boiler with fire tube boiler. Also define equivalent evaporation.

(ii) During boiler trial for 24 hours, total 150 ton of steam at 32 bar and 350°C is generated from feed water at temperature of 30°C. For this 16000 kg of coal with calorific value of 33500 kJ/kg was required. Determine equivalent evaporation and efficiency of boiler.

(c) (i) Steam is available at 10 bar with a dryness fraction of 0.9. Calculate the final state of the steam when there is a loss of 120 kJ/kg of heat from steam at constant pressure.

(ii) Explain draught and obtain the condition for maximum discharge for natural draught system in a boiler.

3. Attempt *any two* of the following questions : **(10x2=20)**

(a) What do you understand by choked flow in a nozzle ? Also discuss its' significance. Obtain

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the expression for the maximum discharge through a convergent-divergent nozzle having isentropic expansion with negligible inlet velocity.

(b) How the actual indicator diagram differs from hypothetical indicator diagram in a steam engine ? Define diagram factor. Dry saturated steam at 12 bar is admitted into the cylinder of a steam engine expands isentropically to a pressure of 0.8 bar. The pressure then falls at constant volume to a back pressure of 0.3 bar. Show the cycle on P-V and T-S plots and compare this modified Rankine cycle with the P-V and T-S plots for the complete Rankine Cycle. Determine work done per kg of steam and thermal efficiency for the modified Rankine Cycle.

(c) (i) Dry saturated steam enters a nozzle at 12 bar and leaves at 1.5 bar with a dryness fraction of 0.95. Neglecting approach velocity calculate the exit velocity. If 12% of the heat drop is lost due to friction, find the percentage reduction in exit velocity.

(ii) Explain supersaturated flow through a nozzle.

4. Attempt *any two* of the following questions : **(10x2=20)**

(a) What are the advantages of compounding of steam turbine ? Describe all methods of compounding, giving neat sketches.

(b) Data pertaining to impulse turbine is as follows :

Steam velocity = 500m/s
Blade speed = 200m/s
Exit angle of moving blade = 25°
Nozzle angle = 20°

Neglecting the effect of friction when passing through blades, determine (i) tangential force, (ii) power obtained, (iii) blade efficiency, and (iv) specific steam consumption.

(c) In a reheat cycle steam leaves the boiler and enters the turbine at 4MPa, 400°C. After expansion in the turbine to 400KPa, the steam is reheated to 400°C and then expanded in the low pressure turbine to 10KPA. Showing the cycle on T-s and h-s plot determine the cycle efficiency.

5. Attempt *any two* of the following questions : **(10x2=20)**

(a) Explain the working of gas turbine cycle. Compare the influence of reheating, regeneration and intercooling on performance of gas turbine cycle.

(b) Explain the working of a jet propulsion system. Also compare the working of Turbo prop, Ram jet and Pulse jet engines.

(c) Consider a gas turbine working on Brayton Cycle. The air enters the compressor at 0.15 MPa and 20°C. The maximum pressure and temperature of the cycle are 1.2MPa and 1200°C respectively. Calculate pressure and temperature at each point in the cycle and cycle efficiency and turbine work for following two cases :

(i) Theoretical Brayton cycle.

(ii) Actual Brayton cycle with turbine and compressor efficiencies of 0.85 each.

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