

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

PAPER ID : 140402 Roll No.

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B.Tech.

(SEM. IV) THEORY EXAMINATION 2013-14

APPLIED THERMODYNAMICS

Time : 3 Hours

Total Marks : 100

Note :- (1) Attempt all questions.

(2) Assume suitably, any missing data.

(3) Be precise in your answer.

(4) Use of steam tables and mollier chart is permitted.

1. Attempt any two of the following : (10×2=20)

(a) Answer the following :

(i) Define volume expansivity, adiabatic and isothermal compressibility.

(ii) What do you understand by dead state ? Determine the loss of available energy when 20 kg of water at 90°C is mixed with 30 kg of water at 30°C at constant pressure. Assume surrounding temperature being 15°C.

(b) Answer the following :

(i) Define adiabatic flame temperature and state its importance.

(ii) Explain Joule-Kelvin effect. What is inversion temperature.

(c) Answer the following :

(i) What is formation reaction and what standard states are normally used while analyzing chemical reaction.

(ii) Propane is reacted with air in such a ratio that analysis of products of combustion gives $\text{CO}_2 = 11.5\%$, $\text{O}_2 = 2.7\%$ and $\text{CO} = 0.7\%$. Find the air : fuel ratio.

2. Attempt any two of the following : (10×2=20)
- (a) Answer the following :
- Define boiler draught and make its classification. Also draw the pressure distribution of air (for combustion) passing through different components of the plants before discharging through chimney, if the boiler is provided with balanced draught arrangement.
 - Make comparison between fire tube and water tube boiler.
- (b) Answer the following :
- How much air is used per kg of coal burnt in a boiler having chimney of 32 m height to create a draught of 20 mm of water column. The temperature of flue gases in the chimney is 375°C and ambient temperature is 30°C.
 - A rigid closed tank of volume 5 m³ contains 8 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry saturated. Determine the final pressure and the heat transfer to the tank.
- (c) Answer the following :
- Steam enters a throttle valve at 25 MPa and comes out of the valve at 2 MPa and 130°C find the quality of steam entering the throttle valve.
 - How does condenser improve the performance of steam power plant ? Discuss the effect of air leakage on the performance of condenser.
3. Attempt any two of the following : (10×2=20)
- (a) Answer the following :
- Prove that steam consumption varies linearly with indicated horse power developed in case of throttle governed simple steam engine.

- Find the throat diameter of a nozzle, if 10 kg/sec air at 10 bar and 200°C expands through it in a space at 1 bar. Approach velocity is 50 m/s.
- (b) What do you understand by the missing quantity of steam ? What is its effect on engine working and how can it be reduced ? A single cylinder double acting steam engine admits dry saturated steam at 12 bar. The cylinder stroke and bore is 40 cm and 30 cm respectively. The clearance is 8% of stroke and the cut-off occurs when the total volume is equal to 0.25 of stroke volume. Assuming a diagram factor of 0.75, calculate the indicated power of the engine if it runs at 250 rpm and the exhaust takes place at 1 bar.
- (c) Write short notes on the following :
- Supersaturated flow through the nozzle.
 - Choking phenomenon in nozzle.

4. Attempt any two of the following : (10×2=20)
- (a) Show the Rankine cycle on P-v, T-s and h-s diagram. A steam power plant has steam entering at 70 bar, 450°C into HP turbine. Steam is extracted at 30 bar and reheated upto 400°C before being expanded in the low pressure turbine upto 0.075 bar. Some portion of the steam is bled out during expansion in LP turbine so as to yield saturated liquid at 140°C at the exit of open feed water heater. Considering HP and LP turbine efficiencies of 80% and 85%. Plot the schematic diagram and T-s chart of the arrangement and determine the cycle efficiency.
- (b) In a impulse steam turbine stage, steam with a velocity of 50 m/s enters the nozzle at 20 bar and dry saturated condition. Steam leaves the nozzle at 5 bar pressure and at an angle of 20° and enters the moving blade without shock. Blade speed ratio and blade velocity coefficient is 0.42 and 0.9 respectively. The outlet angle of the blade of 3° smaller than the inlet angle. The steam flow rate is 5 kg/s.

Draw the velocity diagram and find out blade angles, power developed and axial thrust for the wheel.

(c) Answer the following :

- (i) Discuss the Governing of the steam turbines.
- (ii) Make comparison between impulse and reaction turbine.

5. Attempt any **two** of the following : (10×2=20)

(a) An open cycle gas turbine plant sucks in air at 1 bar and 288 K and compresses it to 6 bar. After passing through regenerator and combustion chamber, the working medium expands in the high pressure turbine which drives the compressor. Further expansion continues in the low pressure turbine. Polytropic efficiency for compression and expansion is 85%, thermal ratio for regenerator = 0.75, maximum cycle temperature is limited to 900 K, specific heat for flue gases is 1.13 kJ/kg K. Find specific output and thermal efficiency of the plant.

(b) Answer the following :

- (i) Derive the condition for optimum pressure ratio for minimum compressor work requirement in two stage perfect intercooled compression.
- (ii) Make comparison between closed cycle and open cycle gas turbine power plant.

(c) Answer the following :

- (i) Define thrust power, propulsive power and propulsive efficiency.
- (ii) Describe the working of turbojet engine and compare it with turboprop engine.