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B.Tech.
(SEM IV) EVEN SEMESTER EXAMINATION, 2015-16
APPLIED THERMODYNAMICS

[Time: 3 hrs.] **[Max. Marks: 100]**

Note- Attempt All Questions. All Questions carry equal marks. Be precise in your answer. Use of Steam table and Mollier chart is permitted.

Q1 Answer any **two** of the following **[10x2=20]**

(a) Answer the following.

(i) Define formation reaction, enthalpy of formation and reference standard state.

(ii) Butane is burned with 90% theoretical air. Find the A/f ratio and dew point temperature of the products if the products are at 2 bar.

(b) Ethane at 25 °C is burned in a steady flow combustion chamber with 20% excess air at 127 °C. if products leave at 1200 K, Find the heat transfer. The pressure remains constant at 1 bar.

(c) Derive the expression of thermal efficiency of otto cycle in terms of compression and cutoff ratio. A diesel engine intakes atmospheric air at 1 bar & 27 °C. heat supplied during the cycle is 1000kJ/kg. If the maximum pressure is 5 MP, find (i) cut off ratio (ii) thermal efficiency (iii) power output for an air flow of 0.1 kg/s.

Q2 Answer any **two** of the following **[10x2=20]**

(a) Discuss the working of two stroke petrol engine with neat sketch. Compare two stroke and four stroke engine on the basis of volumetric, mechanical and thermal efficiency with suitable explanation.

(b) Distinguish between fire tube and water tube boilers. A thermal power plant works on natural draught having chimney of 2 m diameter and 30 m height. The mean temperature of flue gas is 300 °C. Ambient temperature is 32 °C and the air fuel ratio is 20:1, find the draught prodced and mass of flue gas passing through the chimney.

(c) Answer the following

(i) Show the pressure distribution through the different components present in the passage (from air inlet to chimney exhaust) of air/flue gases for induced draught.

(ii) Explain the function of high steam and low water safety valve with suitable sketch.

Q3 Attempt any **two** of the following. **[10x2=20]**

(a) Show that for steady one dimensional isentropic compressible flow through a duct $\frac{dA}{A} = \frac{dV}{V}(M^2\text{-}1)$, and explain its implication in the design of nozzle. Also discuss the phenomenon of choking in nozzle.

(b) State the methods to reduce the initial condensation of stem in steam engine. Show that for throttle governed steam engine, steam consumption (kg/hr) can be expressed as M= A+B*IHP where A & B are constant and IHP is indicated horse power.

(c) A convergent-divergent nozzle expands air at 6.9 bar and 427 °C into a space at 1 bar. The throat area of the nozzle is 650 mm^2 and the exit area is 975 mm^2. The exit velocity is found to be 680 m/s when the inlet velocity is negligible. Assuming that friction in convergent portion is negligible, find the mass flow through the nozzle, coefficient of velocity and state whether the nozzle is underexpanding or overexpanding.

Q4 Attempt any **two** of the following. **[10x2=20]**

(a) Why the mean height of turbine increases from first stage to last stage in case of multi stage turbine. Steam flows from the nozzles of a single row impulse turbine with a velocity of 450 m/s at a direction which is inclined at an angle of 20^0 to the peripheral velocity. Steam comes out of the moving blades with a velocity of 150 m/s at an angle of 70^0. The blades are equiangular. Steam flow rate is 6 kg/s. Draw the velocity diagram and determine the diagram efficiency and power loss due to friction.

(b) Answer the following

(i) Discuss binary vapour cycle.

(ii) Make classification of steam turbines.

(c) In a 50 MW steam turbine power plant, steam is generated in boiler at 90 bar and 500 °C. it is expanded in intermediate pressure stages to an appropriate minimum pressure such that a portion of the steam bled at this pressure for regenerative feed water heating heats the feed water to a temperature of 180 C and the remaining steam is passed to reheater from where it returns to the turbine at 500 °C and further expanded to a condenser pressure of 0.07 bar. Find the thermal efficiency, heat rejected in the condenser and steam rate.

Q5 Attempt any **two** of the following. **[10x2=20]**

(a) Make comparison between open and closed cycle gas turbine plant. Prove that in a two stage compression with perfect intercooling, intermediate pressure for minimum compression work is $P_i = (P_{min} . P_{max})^{1/2}$.

(b) A Brayton cycle gas turbine power plant is operating on pressure ratio of 6. The air enters at 25 C the plant. The maximum temperature of the cycle is 1050 K. The compression is carried out in one stages. The expansion is carried out in two stages of equal pressure ratio with perfect inter-cooling between the stages. The isentropic efficiency of compressor is 0.9 and polytropic efficiency for each turbine is 0.85. Calorific value of the fuel is 44 MJ/kg. Find thermal efficiency and A/F ratio and specific fuelconsumption.

(c) Define propulsive power and propulsive efficiency. Discuss the working of turbo-prop propulsion system with neat sketch.