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B.Tech.
(SEM. IV) THEORY EXAMINATION 2017-18
APPLIED THERMODYNAMICS

Time: 3 Hours**Total Marks: 100**

- Note:**
1. Attempt all Sections.
 2. If require any missing data; then choose suitably.
 3. Use of Steam Tables and Mollier chart is permitted.

SECTION A

- 1. Attempt all questions in brief. 2 x10 = 20**
- a. Define Joule Thomson coefficient.
 - b. What do you mean by isothermal compressibility?
 - c. What is enthalpy of formation?
 - d. Discuss adiabatic flame temperature.
 - e. How equivalent evaporation is used for comparison of boilers?
 - f. What is meant by cogeneration in steam power plant?
 - g. Define propulsive power and propulsive efficiency.
 - h. Why Rankine cycle is modified?
 - i. What is Equivalent Evaporation? Discuss it.
 - j. Define degree of reaction.

SECTION B

- 2. Attempt any three of the following: 10 x 3 = 30**
- a. The % composition by mass of a solid fuel used in a boiler is C=88%, O₂=4%, N₂=2%, S=1% and remaining is incombustible matter. If 50% excess air is supplied in actual combustion, determine the volumetric analysis of the products and also the mass of flue gas per kg of fuel.
 - b. Derive the relation for chimney height. Calculate the height of chimney required to generate a pressure difference of 100 mm of water column. The temperature of outside air is 30 °C and the average temperature of flue gases in the chimney is 150 °C.
 - c. In a steam turbine steam at 20 bar, 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes, find per kg of steam the net work and the cycle efficiency.
 - d. A single cylinder double acting steam engine is supplied with dry and saturated steam at 11.5 bar and exhaust occurs at 1.1 bar. The cut-off occurs at 40% of stroke. If the stroke equals 1.25 times the cylinder bore and engine develops 60 kW at 90 rpm, determine the bore and stroke. Assume hyperbolic expansion and a diagram factor of 0.70. Also calculate the theoretical steam consumption per hour.
 - e. What is the principle of jet propulsion? Classify the jet propulsion engines. Explain the working of turbo jet engines by making neat sketch.

SECTION C

3. Attempt any *one* part of the following: **10 x 1 = 10**
- What do you mean by inversion curve? Prove that joule Thomson coefficient for a perfect gas is zero. Also Discuss the coefficient of volume expansion and adiabatic compressibility.
 - Determine the air fuel ratio of C_3H_8 with 150 percent theoretical air supplied. Also explain the terms 'excess air', 'air fuel ratio', 'flash point', 'fire point', 'lean' and 'rich' mixture.
4. Attempt any *one* part of the following: **10 x 1 = 10**
- What are the essential of a good boiler? Distinguish between Fire tube & Water tube boilers. Give two name of each. Give a neat-labeled sketch of a Lancashire Boiler.
 - Condenser vacuum of a surface condenser is 70 cm of Hg, barometric reading is 76.5 cm of Hg, Mean condenser temperature = $35^\circ C$, hot well temperature = $28^\circ C$, condensate collected = 1800 kg/hr, cooling water inlet temperature = $12^\circ C$, cooling water outlet temperature = $27^\circ C$. Calculate: (i) vacuum efficiency, (ii) condenser efficiency.
5. Attempt any *one* part of the following: **10 x 1 = 10**
- A turbine is supplied with steam at a pressure of 32 bar and a temperature of $410^\circ C$. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of $395^\circ C$ and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle?
 - Derive an expression for mean effective pressure of a steam engine considering the effect of clearance and compression. What do you mean by 'missing quantity'? How it can be minimized?
6. Attempt any *one* part of the following: **10 x 1 = 10**
- Define the Steam Nozzle. Also derive the expressions for **velocity** of steam and **discharge** through steam nozzle.
 - In an impulse turbine the steam issues from the nozzle with a velocity of 850 m/s. Nozzle angle is 20° and mean blade velocity is 350 m/s. The blades are equiangular. The mass flow rate is 1000 kg/min and friction factor is 0.8. Determine: (i) Blade angles, (ii) Axial thrust, (iii) Power, (iv) Blade efficiency, (v) Stage efficiency if nozzle efficiency is 93%.
7. Attempt any *one* part of the following: **10 x 1 = 10**
- Discuss in details the significance of reheating, inter-cooling and regeneration on the performance of gas turbine by making suitable layout and T-s diagram.
 - A gas turbine plants consists of two stage compressor with perfect intercooler and a single stage turbine. If the plants work between the temperatures limits 300 K and 1000 K and 1 bar and 16 bar. Find the net power of the plant per kg of air. Take specific heat at constant pressure 1 KJ/kgK.