(Following Roll No. to be filled by candidate)

Roll No. 1 4 0 4 3 ? 0 0 1 5

THIRD SEMESTER EXAMINATION 2015-16
EME309
THERMAL AND HYDRAULIC MACHINES

Time:3 Hour **Max. Marks: 100**

Note:
- Attempt all questions.
- Marks and number of questions to be attempted from the section is mentioned before each section.
- Assume missing data suitably. Illustrate the answers with suitable sketches
- Notations used have usual meaning.
- Use of steam tables and charts are permitted.

1. Attempt any **two** out of following: [2x10]

a. Three Carnot heat engines E_1, E_2 and E_3 works in series. The amount of work developed is the proportion of 4:3:2. These engine operate between the temperature limits of 900 K and 300 K. (i) Determine the intermediate temperatures (ii) If power developed by the engine E_3 is 6kW, find the overall efficiency of the engine system (iii) prove that the process is a reversible system.

b. Draw the Rankine cycle with reheat and regeneration on p-v and T-s diagram and why efficiency of a Rankine cycle increases with decrease in condenser pressure does.

c. Show that entropy change per kg of a gas from state point 1 to state point 2 for a polytropic process is given by:

$s_2 - s_1 = c_v\left(\frac{\gamma - n}{\gamma - 1}\right)\log_e \frac{T_1}{T_2}$; Where the symbols s, T and c_v represent entropy, temperature and specific heat at constant volume respectively.

2. Attempt any **two** out of following: [2x10]

a. Draw the velocity vector diagram for three-row velocity compounding wheel turbine and set up expression to single stage impulse steam turbine for the axial thrust, tangential force, work done and diagram efficiency.

b. Derive an expression for the optimum pressure ratio giving maximum specific output in simple cycle gas turbine.

c. In gas turbine power plant air inters at 1.0 bar and 30 ^{0}C and leaves the compressor at 5 bar. It is a constant pressure open cycle gas turbine power plant. The temperature of the gas entering the turbine = 680^{0}C, pressure loss

in the combustion chamber = 0.2 bar, compressor efficiency=0.85, turbine efficiency=0.80 and combustion efficiency=0.85, γ = 1.4 and c_p= 1.024kJ/kgK of air and gas, find: (i) The thermal efficiency of the cycle (ii) heat supplied per kg of air circulation (iii) The quantity of air circulation if the plant develops 1050 kW.

3. Attempt any **two** out of following: [2x10]

a. Compare 2-stroke SI engine with 2-stroke CI engines.

b. Discuss the stalling and choking phenomenon in compressor and also explain the characteristic of centrifugal.

c. The following observations were taken during the trial on a four stroke single cylinder engine results: bore=16 cm, stroke=30 cm, speed=310 rpm, brake load=350 N, brake diameter=0.9 m and gas consumption=5 m^3/hr. The calorific value of gaseous fuel=18850 kJ/m^3, cooling water supply=200 kg/hr and cooling water temperature rise=30^{0}C. Indicated mean effective pressure=450 kPa. Determine: (i) mechanical efficiency (ii) indicator thermal efficiency (iii) brake thermal efficiency. Draw the energy balance sheet on per second basis.

4. Attempt any **two** out of following: [2x10]

a. Derive an expression for work done and efficiency of pelton turbine and at what condition the efficiency of turbine will be maximum.

b. A hydroelectric power plant equipped with an axial flow water turbine works under gross head of 40 m. The mean diameter of the runner is 2 m and rotates at 150 rpm. Water leaves the guide vanes at 30^o to the tangential direction. The outlet angle of the runner vanes is 55o. The head loss in the casing and guide vanes is 5% and blade velocity coefficient of the runner is 0.92. Calculate (i) blade angle (ii) work output per kg of water in meter head (iii) hydraulic efficiency.

c. Derive an expression for work done and efficiency of a jet impingement upon a moving curved vane with jet striking tangentially at one tip.

5. Attempt any **two** out of following: [2x10]

a. Derive the expression for pressure rise in the impeller of a centrifugal pump, when friction and other losses in the pump is neglected and flow is radial at inlet, velocity of flow is constant throughout and outlet angle of impeller vane is 45^0.

b. Give sketch of the theoretical pressure-volume diagram for the cylinder of a reciprocating pump which is fitted with air vessels. Show clearly the effect of acceleration and friction in both suction and delivery pipe.

c. Discuss the various characteristics behaviour of centrifugal and reciprocating pumps.