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B Tech.

(SEM-III) THEORY EXAMINATION 2017-18

THERMAL & HYDRAULICS

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

Note: Attempt all Sections. Assume missing data if any.

1. Attempt any FOUR parts: 5x4=20

a) Steam at 10 bar and 200 ^{o}C is cooled till it becomes dry saturated and is then throttled to 1 bar pressure. Determine the change in enthalpy and heat transferred during each process. Also find the quality of steam at the end of throttling process. Take c_{ps} = 2.25 kJ/kg K for superheated steam.

b) Explain reheat Rankine cycle.

c) Drive the expression of maximum blade efficiency of impulse turbine. Steam at 10 bar and 200 ^{o}C is cooled till it becomes dry saturated and is then throttled to 1 bar pressure. Determine the change in enthalpy and heat transferred during each process. Also find the quality of steam at the end of throttling process. Take c_{ps} = 2.25 kJ/kg K for superheated steam.

d) Discuss Zeroth Law of thermodynamics with examples.

e) A heat engine operates between two thermal reservoirs; source at temperature T1 and sink at temperature T2. If the source and sink are of mass 'm' and specific heat 'c', set up the following expression for the maximum work output possible

$W_{max} = m\,c\,\left(\sqrt{T_1} - \sqrt{T_2}\right)2$

f) Consider a steam power plant operating on the simple ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350 ^{o}C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of this cycle.

2. Attempt any TWO parts: 10x2=20

a) Consider a steam power plant operating on the simple ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350^{0} C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of this cycle.

b) m_1 kg of water at T_1 is isobarically and adiabatically mixed with m_2 kg of water at T_2 ($T_1 > T_2$). Show that for equal masses of water, the entropy change of the mixture is given by

$(ds)_{universe} = 2mc_p \log_e \left[\frac{T_1}{2\sqrt{T_1 T_1}}\right]$ and prove that the change is necessarily positive.

c) In a stage of a De-Laval Turbine provided with a single row wheel, the mean diameter of the blade ring is 80 cm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is 20^{0}. The rotor blades are equiangular and blade velocity coefficient is 0.86. What is the power developed in the blades when the axial thrust on the blades is 140 N? A jet of water of the diameter 100 mm moving with a velocity of 20 m/s strikes a curved fixed plate tangentially at one end at an angle of 30º to the horizontal. The jet leaves the plate at an angle of 20º to the horizontal. Find the force exerted by the jet on the plate in the horizontal and vertical directions.

3. Attempt any FOUR parts: 5x4=20

a) A mass of gas is compressed in a quasi-static process from 80 kPa, 0.1 m^3 to 0.4 MPa, 0.03 m^3. Assuming that the pressure and volume are related by pv^n = constant, find the work done by the gas system.
b) Discuss PMMI and PMMII. Prove that Internal Energy is the property of system.
c) Explain regenerative Rankine cycle. A heat engine is supplied with 2512 kJ/min of heat at 650 ^oC**.** Heat rejection takes place at 100 ^oC. Specify which of the following heat rejections represent a reversible, irreversible or impossible result:
(i) 867 kJ/min (ii) 1015 kJ/min (iii) 1494 kJ/min
d) Derive the expression for work saved in single acting and double reciprocating pump by fitting Air Vessel.
e) Explain construction and working of a single acting reciprocating pump. What is slip?
f) A Pelton wheel has a mean bucket speed of 35 m/s with a jet of water flowing at the rate of 1 m^3/s under a head of 270 m. The buckets deflect the jet through an angle of 170º. Calculate the power delivered to the runner and the hydraulic efficiency of the turbine. Assume co-efficient of velocity at 0.98.

4. **Attempt any TWO parts: 10x2=20**

a) In a De-lavel turbine, the steam enters the wheel through a nozzle with a velocity of 500 m/s and at an angle of 20º to the direction of motion of the blade. The blade speed is 200 m/s and the exit angle of the moving blade is 25º. Find the inlet angle of the4 moving blade, exit velocity of steam and its direction and work done per kg of steam.
b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar and 27º C. The pressure ration in the cycle is 6. Calculate the maximum temperature in the cycle and the cycle efficiency. Assume the turbine work as 2.5 times the compressor work. Take γ = 1.4.
c) Explain the construction and working of centrifugal pump.

5. Attempt any TWO parts: 10x2=20

a) Derive the expression of thermal efficiency of Diesel Cycle.
b) An engine working on the Otto Cycle is supplied with air at 0.1 MPa and 35^0C. The compression ratio is 8. Heat supplied is 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle and cycle efficiency. C_p= 1.005, C_v =0.718 kJ/kg K.
c) (1) Differentiate between SI and CI engine.
(2)Explain surging and choking in air compressor.