Ref. No. Ex/PE/T/312/2017(S)

B. Power Engineering 3rd Year 1st Semester Supplementary Examination, 2017

Steam Turbine and Gas Turbine

Time: 3 hrs. Full Marks: 100

Use separate Answer Scripts for each part

Part-I (Marks: 65)

Answer Q. No. 1 and any three from the rest

1. Answer the following questions (Any four) Marks: 4 X 5=20

   i) Deduce the critical pressure ratio $\frac{P^*}{P_1} = \left[\frac{2}{K+1}\right]^{\frac{K}{K-1}}$, for which the discharge through the nozzle is maximum. Where P_1 & P^* are the pressure at nozzle inlet & throat and K is index of adiabatic expansion.

   ii) Show that the maximum efficiency of a 50% reaction turbine is- $\frac{2\cos^2\alpha}{1+\cos^2\alpha}$, where α is the angle at which the steam enters the blade.

   iii) What is the necessity of compounding in impulse steam turbine? Describe the various types of compounding done in impulse turbine.

   iv) Find the power output ratio in different rows in 3 row Curtis stage and prove that it is not justified to use more than 2 rows Curtis stage?

   v) Make a comparison of the diagram efficiency of Impulse turbine, Two-row Curtis stage and 50% Reaction turbine?

   vi) Describe the 'Nozzle governing' and Throttle governing' highlighting their merits and demerits.

   vii) What is the droop characteristic of turbine governing system? If a steam turbine running at full load has rated speed 3000 rpm and has 7% droop characteristic, at what frequency the machine will totally unload?

2. Steam expands in a turbine from 40 bar, 500^0C to 0.10 bar isentropically. Assuming ideal conditions, determine the mean diameter of the wheel if the turbine were of (a) single impulse stage, (b) single 50% reaction stage, (c) four pressure (or Rateau) stages,(d) one two-row Curtis stage, and (e) four 50% reaction stages. Take the nozzle angle as 16^0 and speed as 3000 r.p.m. Marks:15

3. Steam passes from the nozzles of a De Laval turbine with a velocity of 1000 m/s. The nozzle angle is 20^0. Mean velocity is 400 m/s. The blades are symmetrical. The mass flow rate is 1000 kg/hr. Friction factor is 0.8, nozzle efficiency is 0.95. Determine the following:
i) Blade angle, ii) Axial thrust on the rotor turbine, iii) Power developed, iv) Blade efficiency and v) Stage efficiency. Marks:15

4. Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine-
i) The velocity of steam at the throat and at exit.
ii) Ratio of cross section at exit and that at throat.
iii) Find the mass flow if throat area is 1200 mm^2.
Assume the index of adiabatic expansion to be 1.135. Marks:15

5. a) Discuss the different types of rotor used in steam turbine stating their advantages and disadvantages.
b) Discuss the 'Inverted T attachment' and 'Serrated blade root attachment'.
Marks:7+8

6. (a)Write down the different losses in steam turbine. Explain the 'Disc friction loss' and 'partial admission loss' in steam turbine
(b) Derive the relation between nozzle efficiency, blade efficiency and stage efficiency of an impulse turbine?
Marks:2+8+5

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B.Power Engineering 3rd Year, 1st Semester Supplementary Examination, 2017

Subject : Steam & Gas Turbine **Time : Three hours** **Full Mark : 100**

Part – II (Gas Turbine)

Use Separate Answer scripts for each Part **(Total Marks in Part - 35)**

Answer Question No. 1 and any one from the rest

1. Answer any three questions **5×3 = 15**

   (a) Explain the differences between open cycle and closed cycle gas turbine plants and discuss their respective merits.

   (b) Why regeneration is done in a gas turbine engine? How is it done? Show its effect on the T-s diagram.

   (c) Why atomization is important in oil fired gas turbine? How does an air blast atomizer work?

   (d) What is Sauter mean diameter of a fuel oil spray? Why is it considered significant for gas turbine combustor?

   (e) What is soot? What are its effects in gas turbine combustor?

2. A gas turbine operating at a pressure ratio of 11.4 produces no net work output when 476.33 kJ of heat is added per kg of air mass. If the inlet air temperature is 300 K and the turbine efficiency is 71%. Find the compressor efficiency and the temperature ratio. Assume γ=1.4 and C_p=1.005 kJ/kg K for the whole cycle. **(20)**

3. A gas turbine with a regenerator has got the following data:
   Compressor inlet temperature = 290 K, Compressor outlet temperature = 460 K, Inlet temperature to the turbine = 900^{O}C, Outlet temperature from the turbine = 467^{O}C. Assuming no pressure drop in the regenerative heat exchanger, calculate (i) pressure ratio of compressor and turbine, (ii) specific power output, (iii) overall efficiency of the cycle, (iv) work required to drive the compressor. Assume 100% mechanical efficiency. **(20)**