Code No: 55020 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, November - 2015

APPLIED THERMODYNAMICS-II

(Common to ME, AME)

Time: 3 hours **Max. Marks: 75**

Answer any five questions

All questions carry equal marks

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1.a) Give the flow and T-s diagrams of the ideal regenerative cycle. Why is the efficiency of this equal to Carnot efficiency?

b) A Brayton cycle operates with ideal air between 1 bar, 300 K and 5 bar, 1000 K. The air is compressed in two stages with perfect intercooling. Similarly in the turbine expansion occurs in two stages with perfect reheating. Calculate the optimum pressure in bar, network output and the fraction of turbine output that has to be put back to compressor (W_C/W_T). [7+8]

2.a) What is adiabatic flame temperature? How flame temperature can be calculated?

b) The exit area/throat area ratio of a rocket nozzle is 3:1. The combustion pressure and temperature are 20 bar and 3000 K and the atmospheric pressure is 1 bar. Assuming that the expansion is isentropic, estimate the thrust per unit throat area and the specific impulse. For gases assume molecular weight of 33.5 and $\gamma = 1.12$. [7+8]

3.a) Describe with a sketch a turbojet engine and explain its thermodynamic cycle.

b) The following data collected from a steam turbine of 30 MW capacity thermal power plant.
Steam condensed = 50000 kg/hr
Temperature of steam in condenser = 40^0C
Dryness of steam entering into condenser = 0.85
The air leakage in the condenser = 150 kg/hr
Temperature of the condensate = 35^0C
Temperature at the suction of the air pump = 32^0C
Barometer reads 76 cm of Hg = 1.013 bar.
Find: (i) Vacuum gauge reading in the condenser (ii) Capacity of dry-air pump (iii) Loss of steam in kg per hour (iv) Quantity of cooling water passed through the condenser per hour if the rise in cooling water temperature is limited to 10^0C [7+8]

4.a) Why non-condensable gases needs to be removed from the surface condensers continuously? Explain the function of Edward air pump

b) Derive the expression for specific work output and the efficiency of a simple cycle gas turbine with a regenerator. [7+8]

5.a) Show that for maximum diagram efficiency of a reaction turbine is the blade – steam speed ratio is equal to cos α, where α is the angle of absolute velocity at inlet.

b) At a stage of a reaction machine the ring diameter is 140 cm. The speed ratio is 0.7. The speed of rotation is 3000 rpm. Determine the required entrance angle for the blading if the exit angle is 20^0. Determine the work done per kg of steam flowing per sec. Calculate the percentage increase in diagram efficiency if the blades are designed for and run at the best theoretical speed, the exit angle kept 20^0. [7+8]

6. The following particulars apply to a two-row velocity-compounded impulse stage of a turbine.
Nozzle angle = 16^0; blade speed 120 m/s; steam velocity from nozzles 600 m/s; exit angles of first row of moving blades, the fixed blades, and the second row of moving blades are 18^0, 21^0, and 35^0 respectively; blade velocity coefficient for each row of blades 0.9; mass flow rate 5 g/s. Calculate: (a) blade inlet angles for each row; (b) the driving force and the axial thrust on the wheel (c) the diagram efficiency and power developed; (d) the maximum possible diagram efficiency for the given nozzle angle and steam inlet velocity; and (e) the length of the nozzle arc and the blade heights. Assume nozzle height 25 mm, pitch of blades 25 mm, exit tip thickness 0.5 mm and the steam condition leaving nozzles to be dry saturated steam at 5 bar. [15]

7.a) Derive an expression for maximum mass flow through a convergent – divergent nozzle when the steam is expanded from rest.

b) Steam at 2 bar, 150^0 C is admitted to a convergent nozzle of 6.5 cm^2 throat area. The discharge pressure is 1.4 bar. Calculate the velocity of the jet issuing from the nozzle and the mass of steam discharged per second.
If the jet from this nozzle is made to impinge upon a flat plate placed at right angles to the path of the jet, what force is exerted upon the plate. [7+8]

8.a) Describe briefly the advantages which you would expect to be gained from incorporating economizer, air preheater and a superheater in a steam plant. By a line diagram, indicate the position of these accessories in a typical boiler plant.

b) Derive an expression connecting the height of a chimney and the draught it produces in terms of temperature of outside air and the mean temperature of flue gases. State clearly the assumptions made. [7+8]

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