

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), Nov.-Dec. 2015
B. Tech. in Mechanical Engineering, Semester V

Roll No.....

ME 509: APPLIED THERMODYNAMICS

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. Steam table and H-S chart are permitted.
5. Scientific Calculator without programming of any type is allowed.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark)

10

- i. The thermal efficiency of Rankine cycle; (a) increases with increase of inlet steam pressure (b) increases with increase of inlet steam temperature (c) increases with the increase of both inlet steam pressure and temperature (d) decreases with the decrease of both inlet steam pressure and temperature
- ii. A convergent-divergent nozzle is used when the discharge pressure is; (a) less than the critical pressure (b) equal to the critical pressure (c) more than the critical pressure (d) none of the above.
- iii. High pressure boilers have; (a) Small bore tube (b) lighter structure (c) lower number of drums (d) all of the above
- iv. The reheat Rankine cycle operates when; (a) the boiler water is heated in the Boiler Feed water preheater after pumping (b) the exhaust steam is heated after expansion in steam turbine (c) the steam is extracted at the intermediate stage and reheated to the superheating steam (d) none of the above
- v. Which one is true for velocity compounded steam turbine? (a) velocity of steam remains constant in rotors (b) velocity of steam goes on increasing in rotors (c) pressure of steam goes on decreasing in rotors (d) velocity drop takes place in stages, in rotors.
- vi. The state of steam at the outlet of the condenser in the Rankine cycle has a dryness fraction of; (a) 1 (b) 0.5 (c) any value between 0 and 1 (d) zero
- vii. Which one is true for pressure-compounded steam turbine? (a) pressure drop takes place in stages in various stages of nozzles (b) pressure remain constant throughout the stages (c) velocity goes on decreasing throughout the stages (d) velocity goes on increasing throughout the stages.
- viii. The efficiency of the Rankine cycle will improve; (a) in rainy season as there will be abundant supply of the working fluid (b) in summer since the average temperature of the heat supplied increases (c) in winter as it decreases the cooled water inlet temperature (d) none of the above
- ix. The isentropic efficiency of steam turbine ranges from; (a) 50 to 60% (b) 60 to 70% (c) 70 to 80% (d) 80 to 90%

- x. The steam condenser in most thermal power plants operate at a pressure below the atmospheric one because; (a) the thermal efficiency of the Rankine cycle can be boosted by lowering the average temperature at which heat is extracted in the condenser (b) the average temperature during the heat rejection process can be decreased by lowering the turbine exit pressure by the same amount as the condenser pressure (c) both are true
- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- Why does the efficiency of a Rankine cycle increase with decreasing condenser pressure?
 - What is the thermodynamic principle of regenerative feed heating?
 - What do you understand by the term "boiler draught"?
 - What do you mean by undercooling of the condensate?
- Q.3A What is a reheat cycle? When is it recommended in a steam power cycle? 05
- Q.3B What is the reason that the Carnot cycle is not a practical cycle for steam turbine plant even though its efficiency is higher? 05
- Q.4A What is a nozzle and what are its functions? 05
- Q.4B What are the advantages and disadvantages of mercury as working fluid? 05
- Q.5A What do you understand by the term "boiler draught"? 05
- Q.5B What is the effect of maximum pressure, superheater and back pressure on the thermal efficiency of steam turbine power plant? 05
- Q.6A What are the requirements of an ideal working fluid in steam turbine? 05
- Q.6B The mean diameter of the blades of an impulse turbine with a single row wheel is 105 cm. and the speed is 3,000 rpm. The nozzle angle is 18° , the ratio of blade velocity to steam velocity is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle of the blade. The steam flow is 8kg/s. Draw the velocity diagram for the blades and calculate the tangential thrust on the blades. 05
- OR
- Q.6B Explain with the help of neat diagram either Locomotive boiler or Babcock and Wilcox boiler. 05
- Q.7A Explain with neat diagram the working of a surface condenser. 05
- Q.7B How does water loss occurs in cooling tower? 05
- OR
- Q.7B A surface condenser of a large steam power plant receives steam from turbine exhaust at the rate of 1500 ton/hour at 40°C having 88% dryness fraction. The circulating cooling water enters the condenser at 30°C and leaves at 38°C . The pressure inside the condenser is maintained at 0.078 bar. By showing the processes on T-s diagram, calculate the rate of flow of cooling water. 05
- Q.8A The expansion of steam is isentropic in convergent nozzles used in a steam turbine. Estimate the rate of flow of steam from this steam turbine, if the total 10

area of the nozzle at exit is 30cm^2 . At inlet to these nozzles the steam is at 6 bar and 260°C . The exit pressure is 4 bar. Neglect the velocity of approach. Find the condition of steam at exit. If the coefficient of discharge of the nozzles were 0.95, what should be the actual exit area of the nozzles assuming that the velocity, mass flow rate and specific volume are the same?

Q.9A Explain the working of a Simple (de-Laval) turbine with the help of a diagrammatic arrangement. 10

Q.9B In a stage of an impulse turbine provided with a single row wheel, the mean diameter of the blade ring is 80 cm and the speed of rotation is 3,000 r.p.m. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is 20° . The rotor blades are equiangular and due to friction in the blade channels the relative velocity of the steam at outlet from the blades is 0.86 times the relative velocity of the steam entering the blades. What is the power developed in the blades when the axial thrust on the blades is 140 N? 10

OR

Q.9B To provide a natural draught a chimney of height 16 m is used. Calculate (i) The draught in mm of water when the temperature of chimney gases is such that the mass of the gases discharged is maximum, (ii) If the temperature of flue gases does not exceed 350°C find air supplied per kg of fuel, when discharge is maximum. Take ambient temperature as 20°C . 10

-----ALL THE BEST-----