

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

CLASS: B.TECH  
BRANCH: MECH

SEMESTER : IV/ADD  
SESSION : SP/2025

**SUBJECT: ME209 ENERGY CONVERSION SYSTEMS**

TIME: 3 Hours

FULL MARKS: 50

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

-----Steam Tables-----

- |  | CO    | BL  |
|--|-------|-----|
| Q.1(a) Explain the mean temperature heat addition with reference to the Rankine cycle. Discuss briefly the working principle of feed water heaters used in steam power plant and its impact on mean temperature heat addition.   | [5] 1 | BTL |
| Q.1(b) Steam at 90 bar and 480 °C is supplied to a steam turbine. The steam is reheated to its original temperature, passing the steam through reheater at 12 bar. The expansion after reheating takes place to condenser pressure of 0.07 bar. Determine the cycle efficiency of reheat cycle.  | [5] 1 | BTM |
| Q.2(a) Give a brief account on classification of fuels.  | [5] 2 | BTL |
| Q.2(b) The percentage of composition by mass of a solid fuel used in a boiler as follows: C = 90%, H <sub>2</sub> = 3.5%, O <sub>2</sub> = 3%, N <sub>2</sub> = 2% and remainder is ash. (i) Find the mass of air required per kg of fuel for complete combustion and the mass analysis of dry products of combustion, (ii) If 40% excess air is supplied in actual combustion, determine the mass analysis of flue gases per kg of fuel.  | [5] 2 | BTM |
| Q.3(a) Show that for an isentropic flow through a nozzle the maximum discharge takes place when the steam pressure at the throat (p <sub>2</sub> ) to inlet pressure (p <sub>1</sub> ) is given by<br>$\frac{p_2}{p_1} = \left( \frac{2}{n+1} \right)^{\frac{n}{n-1}}$   | [5]   | BTM |
| Q.3(b) Dry saturated steam at 8 bar pressure enters a convergent divergent nozzle and leaves at 1.5 bar. If the flow is isentropic and the corresponding expansion index 1.135, determine ratio of cross-sectional area at exit to throat for maximum discharge.   | [5]   | BTM |
| Q.4(a) Why are steam turbines compounded? Explain with suitable diagram the working principle of velocity compounded steam turbine.  | [5]   | BTL |
| Q.4(b) The mean diameter of the blade of an impulse turbine with a single row of wheel is 105 cm and the speed is 3000 rpm. The nozzle angle 18° and the ratio of blade speed to inlet steam speed is 0.42 and the ratio of relative velocity at outlet from the turbine to that of relative velocity at inlet 0.84. The outlet angle of the blade is 3° less than the inlet blade angle. The steam flow rate is 8 kg/s. Determine i) the axial thrust, ii) power developed in the blade and iii) blade efficiency.  | [5]   | BTM |
| Q.5(a) Explain the reasons for using condensers in steam power plant. Describe the working principle of surface condenser used in steam power plant.   | [5]   | BTM |
| Q.5(b) The following observations were obtained during a test on a surface condenser: Vacuum in the condenser = 71 cm of Hg, Barometer reading = 76.5 cm of Hg, Temperature in condenser = 32 °C, Hotwell temperature = 30 °C, Cooling water circulated = 48000 Kg/hr, Inlet and outlet temperature of cooling water = 14 °C and 28 °C, Condensate collected = 1500 Kg/hr. Determine (i) mass of air leak into the condenser per m <sup>3</sup> of condenser volume, (ii) dryness fraction of steam entering the condenser and (iii) condenser efficiency. | [5]   | BTM |