BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

Name: ……………………………………………. Roll No.: …………………………………………..
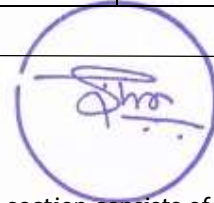
Branch: ……………………………………………. Signature of Invigilator: ……………………

Semester: IVth   Date: 29/04/2022 (MORNING)

Subject with Code: **ME209 ENERGY CONVERSION SYSTEMS**

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.

2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**

3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.

4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.

5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.

6. Write on both side of the leaf and use pens with same ink.

7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.

8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.

9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.

10. Always maintain the highest level of integrity. Remember you are a BITian.

11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

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

CLASS: BE   SEMESTER : IV
BRANCH: MECHANICAL   SESSION : SP/22

SUBJECT: ME209 ENERGY CONVERSION SYSTEMS

TIME: 2 HOURS   FULL MARKS: 50

INSTRUCTIONS:
1. **Question no.1 contains 15 objective type questions which are compulsory to answer.**
2. **Out of Question nos. 2 to 8, any 4 questions are to be solved.**
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. **Use of "Steam Table and Mollier Chart" is allowed.**

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1. Choose the correct answer   [2 x 15 = 30]

   1. What is the effect of superheated steam on efficiency of Rankine cycle?
      a. Efficiency of Rankine cycle decreases with increase in superheat of the steam
      b. Efficiency of Rankine cycle increases with increase in superheat of the steam
      c. Efficiency of Rankine cycle is not affected by change in superheat of the steam
      d. None of these
   2. All of the following statements are correct, except
      a. chimney needs no auxiliary power for its operation
      b. In induced draught, the fan is placed near or at the base of chimney
      c. Balanced draught is the chimney draught supplemented by induced draught
      d. compared to induced draught, the forced draught fan provides more uniform flow of air through the grate
   3. Dry air at a temperature of 27 °C and pressure of 20 bar enters a nozzle and leaves at a pressure of 4 bar. The mass of air discharged; if the area of the nozzle is 200 mm^2 will be:
      a. 48.1 kg/min
      b. 72.1 kg/min
      c. 43.2 kg/min
      d. 52.2 kg/min
   4. The critical pressure ratio for initially dry saturated steam is.......
      a. 0.528
      b. 0.546
      c. 0.577
      d. 0.582
   5. Running speed of a steam turbine can be brought down to practical limits by which of the following method (s)?
      1. By using heavy flywheel
      2. By using a quick response governor
      3. By compounding
      4. By reducing fuel feed to the furnace

      a. 3 alone
      b. 1,2,3 and 4
      c. 1, 2 and 4
      d. 2 and 3
   6. Steam condenser generally used in steam power plant for.......
      a. To decrease expansion ratio
      b. To increase temperature of expansion steam
      c. To reduce back pressure of steam
      d. All of above

7. In an impulse-reaction turbine, the heat drops in the fixed and moving blades are 15 kJ/kg and 30 kJ/kg respectively. The degree of reaction for this stage will be
    a. 1/3
    b. 1/2
    c. 2/3
    d. 3/4
8. Effect (s) of supersaturated flow results as
    1. Increased entropy and specific volume
    2. Increased dryness fraction and reduced exit velocity
    3. Enthalpy drops and exit velocity reduces
    4. Increased exit velocity and entropy

    a. 1 & 4 are correct
    b. 1, 2, & 3 are correct
    c. 2, 3 & 4 are correct
    d. 3 & 4 are correct
9. The quality of steam at turbine exhaust is maintained at the permissible value, depending on?
    a. the inlet steam pressure and temperature
    b. the condenser temperature
    c. the turbine blade erosion in its later stages
    d. all of the above
10. Bleeding in steam turbine means
    a. Leakage of steam
    b. Condensation of steam over the blades
    c. Blade fractures because of steam pressure thereby travel to opposite side.
    d. Steam extraction from turbine during expansion to preheat feed water
11. The biggest energy loss in the steam generator occurs due to?
    a. incomplete combustion of fuel
    b. dry exhaust gas leaving the chimney
    c. unburnt carbon
    d. moisture and hydrogen in fuel
12. The effect of considering friction in steam nozzles for the same pressure ratio leads to
    a. increase in dryness fraction of exit steam
    b. decrease in dryness fraction of exit steam unburnt carbon
    c. no change in quality of the steam
    d. may decrease or increase of dryness fraction of exit steam depending upon inlet quality
13. Which of the following phenomenon does not lead to loss of water in a condenser?
    a. Evaporation loss
    b. Seepage loss
    c. Blowdown loss
    d. Drift loss
14. Determine the thermal efficiency of a boiler given that its equivalent evaporation is equal to 10 kg steam per kg coal, and the calorific value of the coal is 26 MJ/kg. Take the latent heat of evaporation of water at standard atmospheric pressure equal to 2257 kJ/kg.
    a. 86.8 %
    b. 88.2 %
    c. 89.5 %
    d. 90.7%
15. In most steam power plants, closed feedwater heaters are favoured, but one open heater is used to?
    a. to reduce cost
    b. to achieve better heat transfer
    c. to provide high feed water temperature
    d. to deaerate the feed water by removing the dissolved gas

Solve any 4 questions from the following: [5 x 4 = 20]

2. Steam at 20 bar and 350°C is supplied to a turbine where its expansion takes place to a condenser pressure of 0.04 bar. Calculate its thermal efficiency. It is desired to improve the efficiency by the regenerative feed heating by bleeding steam at 2 bar and heating in open feed heater. Calculate the percentage improvement in thermal efficiency. Neglect pump work. [5]

3. During a boiler trial, the dry flue gas analysis by volume was reported as CO_2 13%; CO 0.3%; O_2 6%; N_2 80.7%. The coal analysis by mass was reported as C 62.4%; H_2 4.2%; O_2 4.5%; moisture 15%; ash 13.9%. Calculate: (i) Minimum air required to burn 1 kg of coal, and (ii) The amount of excess air supplied per kg of coal burnt. [5]

4. Steam enters a nozzle at 10 bar and 250°C. It expands isentropically through the nozzle and leaves it at exit pressure is 2 bar. Assuming negligible inlet velocity, determine (i) the pressure and the area at the throat of nozzle, and (ii) the condition of steam and the area of nozzle at the exit. Consider mass flow rate of steam as 1kg/s. [5]

5. The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/s. The blades operate close to the maximum blading efficiency. The nozzle angle is 20°. Considering equiangular blades and neglecting blade friction, calculate the power developed and the blade efficiency for a steam flow of 0.6 kg/s. [5]

6. Prepare a format of Heat Balance Sheet mentioning the expressions of the various types of heat losses during a boiler trial. [5]

7. Derive an expression for maximum discharge rate of gases through the chimney for a given height of the chimney. [5]

8. State the need of steam condenser in a thermal power plant. What is its working principle? How the condensers are classified? [5]

::::: 29/04/2022 :::::

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