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Code No: 5221AG **R15**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M.Tech I Semester Examinations, February - 2016**
**THERMAL AND NUCLEAR POWER PLANTS**
**(Thermal Engineering)**

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

**Note:** This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

## PART - A

**5 × 5 Marks = 25**

1.a) What are the advantages of pulverized coal firing system? Name the different types of air supplied for combustion; and why they are provided? [5]

b) Explain basic fluidised bed system with neat sketch. Also mention some of its advantages. [5]

c) What are the various issues related to nuclear power plant safety? Explain gas centrifuge type of enriching the uranium. [5]

d) Discuss the sinking fund method of finding the depreciation rate. [5]

e) Enlist various temperature measuring instruments. Describe any one of them. [5]

## PART - B

**5 × 10 Marks = 50**

2.a) Enlist basic requirements of combustion equipment's. Discuss any two site selection parameters for steam turbine plant.

b) Steam at 60 bar and 500$^0$C is supplied to a steam power plant of 30MW capacity. The condenser vacuum is 370 mm of Hg when barometer reads 760 mm of Hg. The steam is bled at 7 bar and used for feed heating in direct contact type heater. Assume isentropic efficiency of turbine 90%, determine fraction of steam bled for feed heating and boiler generation capacity. [4+6]

**OR**

3.a) Explain the Indian Power Scenario and explain the significance of Thermal Power Generation in it.

b) Feed water from the high pressure heater enters the inlet header of the economiser at the rate of 600 kg/s and at 140 bar, 170$^0$C. It is heated by flue gases till it becomes saturated liquid at that pressure and leaves the outlet header to flow into the drum. Flue gas flow over the economiser coils at the rate of 1250 kg/s and leaves at 450$^0$C. To restrict the erosion rate by fly ash, the flue gas velocity should not exceed 12 m/s, while the optimum water velocity leaving the coils is 1.2 m/s. The tube are 70 mm OD and 60 mm ID. The overall heat transfer coefficient may be taken as 70 W/m$^2$K. Determine the number of coils required in the economiser and the length of the coil. Take Cp of flue gases as 1.12 kJ/kgK. If the vertical pitch of the coil is 80 mm and the clearance on the two sides of the duct of width 4.8 m is 5 mm, find the vertical height of the economiser coils. [4+6]

4.a) Discuss advantages and disadvantages of gas turbine plant over steam plant and diesel plant.

b) An open circuit gas turbine receives air at $22^0$C and compresses it to 4.8 times the intake pressure with an isentropic efficiency of 84%. A heat exchanger transmits 75% of the heat available for this purpose from the turbine exhaust to compressed air, which then passes through the combustion chamber where its temperature is raised at constant pressure to $887^0$C. The turbine has an isentropic efficiency of 78% and exhausts through the exchanger to the atmosphere. Calculate the thermal efficiency of the cycle, taking $\gamma = 1.39$ for compression and 1.34 for expansion and disregard the fuel mass. Assume that in the regenerator, the mean specific heat is the same for the exhaust products as it is for the fresh charge. Take $C_p$=1.130 kJ/kg$^0$C and 1.025 kJ/kg during combustion and exhaust processes, respectively. [4+6]

**OR**

5.a) What is the significance of the mean temperature of heat addition and why it is accounted for?

b) In an air-standard regenerative gas turbine cycle the pressure ratio is 5. Air enters the compressor at 1 bar, 300K and leaves at 490 K. The maximum temperature in the cycle is 1000K. Calculate the cycle efficiency, given that the efficiency of the generator and the adiabatic efficiency of the turbine are each 80%. Assume for air, the ratio of specific heats is 1.4. Also show the cycle on T-S diagram. [4+6]

6. Enumerate and explain essential components of a nuclear reactor. Also draw neat sketches wherever it is necessary. [10]

**OR**

7. Discuss the safety of Nuclear Power Plant.What do you mean by 'Economics of nuclear power plants'? Discuss the application of nuclear power plant explain. [10]

8.a) A power station has an installed capacity of 210 MW. The cost of the station is Rs. 2 crore per MW. The fixed costs are 16% of the cost of investment. On full load at 100% load factor, the variable costs of the station per year are 1.5 time the fixed costs. Assume that there is no reserve capacity of the plant and that the variable costs are proportional to the energy production. Find the cost of generation per kW at load factors of 100%, 80%, 60%, 40% and 20%. Plot the curve.

b) What are the various criteria for optimum loading? [8+2]

**OR**

9. A power generating station has a maximum demand of 10000kW and the daily load on the station is as follows:

| Time | kW | Time | kW |
|---|---|---|---|
| 6 a.m. to 8 a.m. | 2,500 | 5 p.m. to 7 p.m. | 9,000 |
| 8a. m. to 12 noon | 9,000 | 7 p.m. to 9 p.m. | 15,000 |
| 12 noon to 1 p.m. | 3,000 | 9 p.m. to 11 p.m. | 6,000 |
| 1 p.m. to 5 p.m. | 10,000 | 11 p.m. to 6 a.m. | 2,000 |

a) Draw the load curve and load duration curve.
b) Choose the size and number of generating units.
c) Draw up the operating schedule of the units.
d) What reserve plant would be necessary?
e) Calculate the load factor, plant capacity factor and plant use factor of the station. [10]

10.a) The products of combustion of an unknown hydrocarbon fuel $C_xH_y$ have the following composition as measured by an Orsat apparatus: $CO_2$ 10.0%, CO 1.3%, $O_2$ 9% and $N_2$ 79.7%. Determine i) the value of x and y, ii) the air fuel ratio, iii) the composition of the fuel, and iv) the percentage of excess air used.

b) How solid flow is measured? Explain Nutating disk type of flowmeter. [6+4]

**OR**

11. Distinguish between the Fahrenheit and Celsius temperature scales. State the law of intermediate metals for thermocouples. What is the Seebeck effect? Why is a reference temperature necessary when using thermocouples? [10]

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$1.8^\circ \times C + 32 = {}^\circ F$

$1.8^\circ + 100\,^\circ C + 32 = x\,F$

$180 + 32 = 212\,F$