Department of Mechanical Engineering
Indian Institute of Technology New Delhi
I Semester -- 2006 - 2007

MEL 725 POWER PLANT STEAM GENERATORS
MAJOR EXAMINATION

Time : 2 hrs **Max. Marks: 70**

Problem 1 :

A steam Generator consumes 200 tons of coal per hour. The coal has following ultimate analysis:

Ultimate Analysis of Fuel

M = 14.0%	C = 61.0%
H_2 = 4.0%	O_2 = 6.5%
A = 11.5%	N_2 = 1.4%
S = 1.6%	

HHV = 25353 kJ/kg

An excess air of 24% with a specific humidity of air = 22 gms per kg of Dry air at 25°c & 100 kPa is used as combustion air to get following distribution of total carbon in combustion products.

97.0% of total carbon (by mass) is getting converted to CO_2.

0.8% of total carbon is remaing as unburnt carbon (UC).

2.2% of total carbon is getting converted to CO.

Calculate the dry exhaust gas analysis.

Flue gas temperature = 295°C;

Fuel and room temperature = 25°C;

Specific humidity of air = 22 gms per kg of Dry air ;

Bottom Solid refuse temperature = 640 °C;

fraction of bottom solid refuse = 0.25;

Conduction and Radiation losses = 3% of total losses;

Prepare a table of various energy losses. Calculate the boiler efficiency and estimate the rate of thermal pollution generated by the boiler. Assume relevant data.

25 marks

Problem 2 :

Bituminous coal with a LHV of 31,100 kJ/kg is available from a coal mine. A furnace with following dimensions is avaialble .

h_{fu}, m	a, m	b, m	h_b, m
25.5	23	26	12.4

Find out maximum allowable rate of coal consumption in the above furnce, Which design constraint limits the capacity of the steam generator.

Anlayses of coal and flue gas generate following data.

Flue gas/fuel (mass basis) ratio: 13.2

specifi heat of flue gas: $C_p = 1.005 + 0.000078 \times (T - 288)$, where T is the temperature of flue gas in Kelvin.

Compute the Furnace exist gas temperature by assuming relevant heat transfer properties. **15 marks**

Problem 3:

Based on the design of the furnace given in *problem 2*, estimate the capacity of the platten superheater and design a platen super heater if the operating pressure is 17.5 Mpa. Assume relevant data and give justification for the same.

15 marks

Problem 4:

(a) Discuss the primary requirements of a burner. (b) Explain the role of swirl on the performance of a coal burner. (c) Derive an expression for swirl number of an axial swirl burner. Discuss the effect of design parameters on the performanee of burner.

15 marks