The Open University of Sri Lanka
Bachelor of Technology
ECX 6332-Power Systems Planning
Final Examination 2010/2011

Duration Three Hours

Date: 22rd March 2011 Time: 1400-1700 hrs.

This paper contains Eight (8) questions. Answer any Five. All questions carry equal marks.

1. Explain the difference between a run-of-river scheme and a pumped storage scheme with respect to hydro electric power generation. [8 Marks]

   The weekly discharge of a typical hydroelectric plant is as given below.

Day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Discharge (m^3/sec)	500	520	850	800	875	900	546

   The plant has an effective head of 15 meters and an overall efficiency of 85%. If the plant operates at a weekly capacity factor of 40%, estimate:

   (i) The average daily discharge [4 Marks]
   (ii) Pondage required [4 Marks]
   (iii) Installed capacity of the proposed power plant [4 Marks]

2. Two generators have the following generation cost variations as a function of their output. F is expressed in units of currency per hour

$$F_1 = 10000 + 1000P_1 + 0.5P_1^2 \qquad 100 \le P_1 \le 300 \ MW$$

$$F_2 = 12000 + 1050P_2 + 0.75P_2^2 \qquad 50 \le P_2 \le 200 \ MW$$

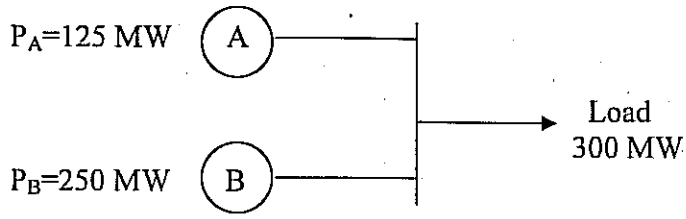
   If the transmission losses to serve the system demand can be approximated with the following expression linearized around a probable operating range of generators as

$$P_L = 0.03P_1 + 0.05P_2 \ MW$$

   Determine the output of each generator against the total system demand of 400 MW such that the total operating cost will be minimized. [20 Marks]

3. If the governor of a generator has twice the percentage droop of the governor of a second generator in an interconnected power system, explain how this would affect the load sharing among the generators for changes in total load. Explain the significance of having the same governor droop in p.u. for generators in a power system. [10 Marks]

   Two turbo generators rated to 125 MW and 250 MW have governor droop characteristics of 10% from no-load to full-load. They are connected in parallel to share a load of 300 MW. Determine the load shared by each machine assuming free governor action. [10 Marks]

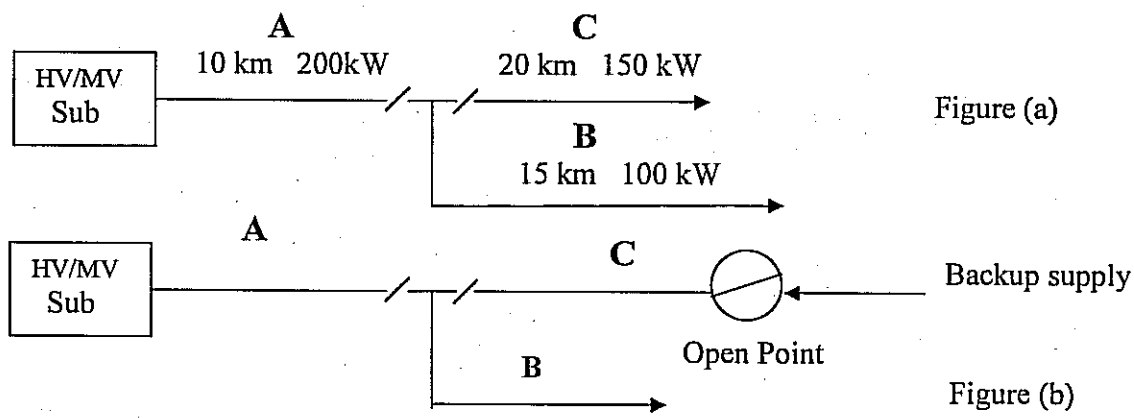


4. In the figure (a) given below, the system is divided into three sections. Calculate the expected annual outage time and outage costs for customers in the different section and for the whole system. [10 Marks]

Figure (b), shows a backup circuit available from a neighboring substation for the system described under figure (a). Re-calculate the expected annual outage time and outage costs for customers in the different sections and for the whole system. Compare the results. [10 Marks]

You may make the following assumptions:

- The failure is approximately proportional to the length of the line, and failure rate is 0.07 per km per year
- The outage cost parameters are 0.6/kW and $ 3/kWh.
- The switching time is 1 hour and the repair time is 3 hours.



5. i) Briefly explain three forecasting techniques used by the electric utilities over the years. [6 Marks]

ii) The demand for electricity in a district from 2005-2009 is given below:

Year	Sales(GWh)
2005	3200
2006	4250
2007	4750
2008	5000
2009	5250

a) Fit a trend profile to the above data using linear variation

Sales = a + b (Time) [7 Marks]

b) Check the goodness of fit (R^2) for the model you have developed under (a). Would you accept the profile (if so, on what basis), or reject? [7 Marks]

You may use the following statistical formulae applicable to the least-square estimation method:

For Y= a + b.X

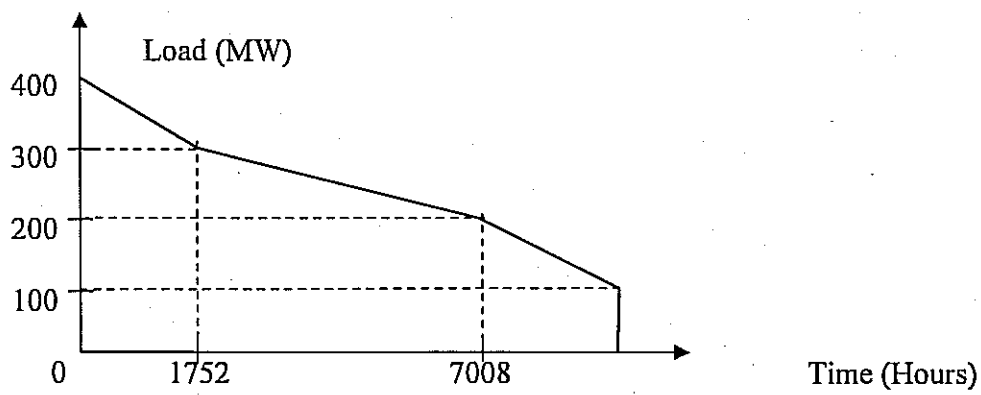
$$a = \left\{ \frac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n} x_i^2 - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} x_i y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \right\} \qquad b = \left\{ \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \right\}$$

$$R^2 = \frac{\text{explained variation}}{\text{total variation}} = \frac{\sum_{i=1}^{n} (y_i^e - \bar{y})^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$

6. A power system is served by five generators where the installed capacities and forced outage rates are tabulated below:

Merit order loading	Plant ID.	Installed Capacity (MW)	Forced outage rate
1	A	100	0.1
2	B	100	0.1
3	C	100	0.1
4	D	100	0.1
5	E	100	0.1

If the generating system described above is serving a load described by the following load duration curve (LDC):



Calculate the following:

- Annual Energy to be served [2 Marks]

Develop the Remaining Load Duration Curves for each generator (RLDCs) and estimate:

- LOLE (loss of load expectation) [4 Marks]
- ENS (Energy not served) [4 Marks]
- Energy served & plant factor for each generator [10 Marks]

7. (i) Write a short note about the selection of a site for a "Nuclear Power station". The following points should be kept in view in your write-up:

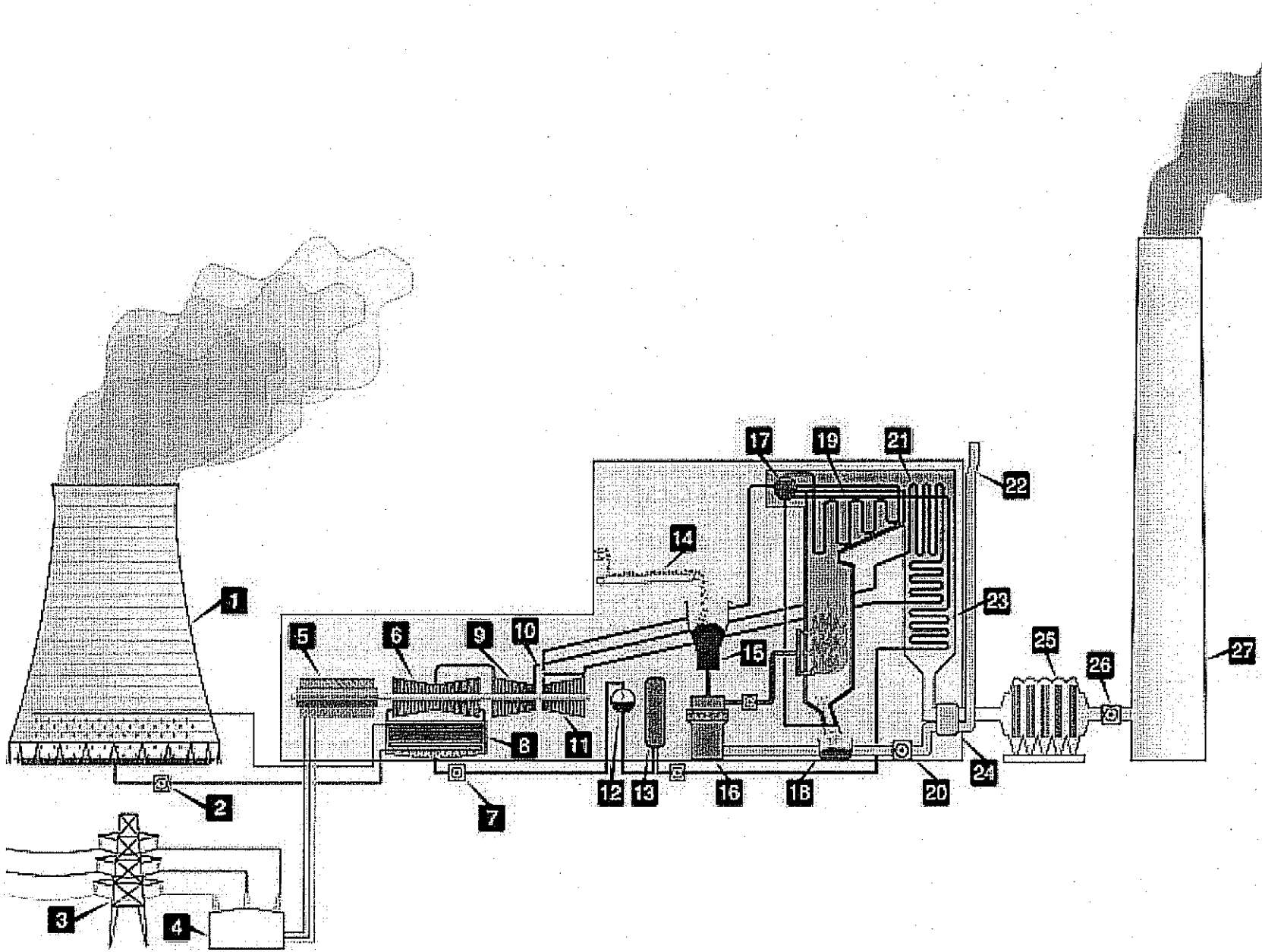
a) Availability of water
b) Disposal of waste
c) Distance from populated areas
d) Transportation facilities [6 Marks]

(ii) Explain the word "Chain reaction" with respect to nuclear power generation [4 Marks]

(iii) What is the power output of a U_{92}^{235} reactor if it takes 30 days to use up 2 kg of fuel, given that energy released per fission is 200 MeV
Assume that 1 eV= 1.6×10^{-19} J and 1 gram-atom (i.e. 235 g)= 6.023×10^{23} atoms. [10 Marks]

8. The schematic arrangement of a Power Plant is shown in figure Q8, Page [5] of [5]. Identify:

- The type of the Power Plant and [3.2 Marks]
- The stages from 1-28. [16.8 Marks]



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