



Name :

Roll No. :

Invigilator's Signature :

**CS/M.Tech(EE)/SEM-2/CAM-205(B)/2012
2012**

POWER SYSTEM OPERATION & CONTROL

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer any five of the following. $5 \times 14 = 70$

1. a) Derive the optimum condition for hydro-thermal scheduling considering network losses.

- b) A hydrothermal system is considered which consists of one thermal and one hydro-generating station. The operating cost of thermal station is given by :

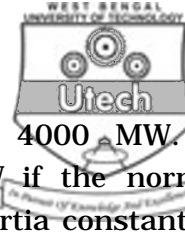
$$F_1 = 100 + 0.1 P_1 + 0.01 P_1^2 \text{ Rs./hr}$$

The rate of discharge of hydro-generating station is given by :

$$q_1 = 140 + 20 P_2 + 0.05 P_2^2 \text{ m}^3/\text{hr}.$$

Assume that the transmission losses are 0 and the reservoir is large. The water available in the reservoir is :

$V_1 = 25,000 \text{ m}^3$ and the total demand for the first hour is 250. Find the economic schedule. (Perform up to 2 iterations and use equal amount of hydel and thermal generation as an initial case) 7 + 7



2. a) A sub-grid has a total capacity of 4000 MW. It encounters a load increase of 50 MW if the normal operating load is 2500 MW. Assume inertia constant to be 5 secs and regulation of the generators in the system as 3 Hz/pu MW. Find :

- i) ALFC loop parameters
- ii) Static frequency drop
- iii) Transient response of ALFC loop.

(Assume load frequency dependency to be linear)

- b) Derive the equation for transient response of an ALFC loop. 9 + 5
3. a) Derive the optimum condition for economic load dispatch considering network losses.
- b) Determine the economic schedule to meet the demand of 150 MW and the corresponding cost of generation. Data given are :

Unit 1 :

$$F_1 (P_1) = 200 + 10.333 P_1 + 0.00889 P_1^2 \text{ Rs./hr}$$

Unit 2 :

$$F_2 (P_2) = 240 + 10.833 P_2 + 0.00741 P_2^2 \text{ Rs./hr}$$

The transmission losses are given by :

$$P_L = 0.001 P_1^2 + 0.001 P_2^2 - 2 \times 0.0002 P_1 P_2$$

(Perform two iterations) 6 + 8



4. Prove that :

$\hat{x} = (H^T W H)^{-1} H^T W z$, where the symbols have their usual meanings.

Estimate two values of random variables x by WLSE method for a given measurement vector z and weighing vector y as :

$$z = \begin{bmatrix} 0.71 \\ 0.65 \\ 0.75 \end{bmatrix}, \quad H = \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 1 \end{bmatrix}, \quad W = \begin{bmatrix} 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.4 \end{bmatrix}$$

Also find : i) covariance of estimation error if $R = I$
ii) optimum value of error covariance matrix.

5 + 9

5. a) Write the algorithm for non-linear state estimation.
b) Derive the optimum condition for long-term hydro-thermal scheduling. What is the power at the optimum condition ?
c) What do you mean by B co-efficients ? What are the constraints in economic dispatch problem ? 3 + 7 + 4
6. a) Consider a 3 bus system. The series impedance and shunt admittance of each line are :

($0.0197 + j 0.0788$) pu and $j 0.04$ pu respectively.
The bus specification and power input at the bus is as under :

Bus	P_G	Q_G	P_L	Q_L	Bus voltage
1	—	—	2.0	1.0	$1.04 \angle 0^\circ$ pu
2	0.5	1.0	—	—	unspecified
3	—	—	1.5	0.6	$1.04 \angle 0^\circ$ pu

Form Y_{bus} , P_2^0 , Q_2^0 , P_3^0 and voltage of bus 2 by N-R method (perform one iteration).



- b) What is the significance of swing bus in load flow studies ? 12 + 2

7. a) Use Dynamic programming method to determine the most economical units to be committed to supply a load of 9 MW. There are 4 units with the following data :

$$C_1 = 23 P_1 + 0.45 P_1^2$$

$$C_2 = 22 P_2 + 0.5 P_2^2$$

$$C_3 = 21 P_3 + 0.5 P_3^2$$

$$C_4 = 20 P_4 + 0.5 P_4^2$$

The maximum and minimum limits for each unit are 6 MW and 1 MW respectively.

- b) What are the constraints in Unit Commitment problem ? 12 + 2

8. Write short notes on any two of the following : 7 + 7

- a) Deregulation
- b) Dynamic programming method
- c) Optimal power flow.

=====