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 × 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 :

   $F_1 = 100 + 0 \cdot 1 P_1 + 0 \cdot 01 P_1^2$ Rs./hr

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

   $q_1 = 140 + 20 P_2 + 0 \cdot 05 P_2^2$ m^3/hr.

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

   $V_1 = 25{,}000$ 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 :

$F_1 \left(P_1 \right) = 200 + 10{\cdot}333\, P_1 + 0{\cdot}00889\, P_1^{\,2}$ Rs. / hr

Unit 2 :

$F_2 \left(P_2 \right) = 240 + 10{\cdot}833\, P_2 + 0{\cdot}00741\, P_2^{\,2}$ Rs. / hr

The transmission losses are given by :

$P_L = 0{\cdot}001\, P_1^{\,2} + 0{\cdot}001\, P_2^{\,2} - 2 \times 0{\cdot}0002\, P_1\, P_2$

(Perform two iterations) 6 + 8

4. Prove that :

$\hat{x} = \left(H^T \ WH \right)^{-1} H^T \ W_z$, 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 :

$$z = \begin{bmatrix} 0 \cdot 71 \\ 0 \cdot 65 \\ 0 \cdot 75 \end{bmatrix}, \quad H = \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 1 \end{bmatrix}. \quad W = \begin{bmatrix} 0 \cdot 3 & 0 & 0 \\ 0 & 0 \cdot 5 & 0 \\ 0 & 0 & 0 \cdot 4 \end{bmatrix}$$

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 L 0° pu
2	0·5	1·0	—	—	unspecified
3	—	—	1·5	0·6	1·04 L 0° 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 :

$$C_1 = 23\, P_1 + 0{\cdot}45\, P_1^{\,2}$$

$$C_2 = 22\, P_2 + 0{\cdot}5\, P_2^{\,2}$$

$$C_3 = 21\, P_3 + 0{\cdot}5\, P_3^{\,2}$$

$$C_4 = 20\, P_4 + 0{\cdot}5\, P_4^{\,2}$$

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.