Ex/PG/EE/T/128C/2017

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER - 2017

POWER SYSTEM OPERATION

Time : Three hours | Answer any four questions. | Full marks : 100

1. a) Explain the terms 'Fuel Cost' and 'Incremental Fuel Cost' of thermal generating units and, with necessary deductions, explain their roles in the most economic dispatch of thermal units. What are the effects of the output limits of the units on the most economic dispatch? Discuss the advantage of using quadratic fuel cost characteristics in the solution of the economic dispatch problem. Also write down an algorithm for the solution of the economic dispatch problem under such assumption. 13

   b) The cost characteristics of the three units of a thermal power plant are as follows: 12

   $C_1 = 0.200P_1^2 + 760P_1 + 2500$ Rs/hr.

   $C_2 = 0.485P_2^2 + 780P_2 + 750$ Rs/hr.

   $C_3 = 0.145P_3^2 + 650P_3 + 4000$ Rs/hr.

   The output limits are

   $100\text{MW} \leq P_1 \leq 400\text{MW}$

   $50\text{MW} \leq P_2 \leq 200\text{MW}$

   $150\text{MW} \leq P_3 \leq 400\text{MW}$

   Determine the most economic output of each unit when the plant load is 700MW and 900MW.

2. a) Show that the 'Incremental Cost of received power' should be same for all units for the most economic dispatch when transmission loss can not be neglected. Discuss the physical significance of 'Penalty Factor'. 10

   b) A power system having three termal plants has the following B co-efficients: 5

   $B_{11} = 0.00010$, $B_{22} = 0.00005$, $B_{33} = 0.00012$.

   All other co-efficients are zero.

   Calculate the incremental transmission losses and penalty factors of the three plants when their outputs are:

   $P_1 = 350\text{MW}$; $P_2 = 300\text{MW}$: $P_3 = 250\text{MW}$.

   c) Explain the terms 'Base Point' and 'Participation Factor' and discuss their roles in real-time economic dispatch. 10

3. With a neat sketch of the speed governing system explain its function and develop the transfer function model of the LFC system of a single generator supplying and isolated load. Also show the effect of governor droop on the steady state frequency deviation following a step load change with the speed changer setting remaining fixed. Also show the role of the speed changer setting in nullifying the steady state frequency error. What type of control do 25

you suggest for automatic adjustment of the speed changer setting to keep the steady state frequency error at zero? - justify.

4 a) Explain the term 'Control Area' in the context of LFC. 13
Develop the transfer function model of a tie-line connecting two power system areas and hence show how the LFC models of those two areas can be connected by model of the tie-line to obtain a two area LFC model.

b) Two 50 Hz areas having capacity of 1500 MVA and 900 MVA are connected by a tie-line. The governor regulation and load damping factor are 5% and 1% respectively for both systems but with respect to their respective individual capacities. Calculate the steady state change in frequency and tie-line flow following a sudden drop in load of 100MW in the first area. Derive the expressions for steady state change in frequency and tie-line power you might have applied to solve the problem. Also calculate the change in generation in each area. 12

5. a) What are the different costs and constraints considered in unit commitment problem? Explain why dynamic programming is suitable for the solution of the unit commitment problem. Also discuss how dynamic programming can be used for the solution of this problem. 15

b) Discuss how short-term hydro-thermal scheduling problem can be mathematically formulated. Also discuss a method for its solution 10

6. Explain why state estimation is important in power system operation. Discuss the method of WLSE and also discuss how that method is applied in power system state estimation. 25