Ref: EX/PG/EE/T/128C/2018

MASTER OF ELECTRICAL ENGINEERING $2^{ND}$ SEMESTER EXAMINATION 2018

# POWER SYSTEM OPERATION

Time: Three hours — Full Marks: 100

Answer **any four** questions.
Figures in the margin indicate full marks

1.(a) Explain what you mean by 'cost characteristics' and 'incremental cost characteristics' of a thermal generating unit. With necessary derivation show how these quantities are involved in the most economic dispatch of thermal units of a power plant. Write down an algorithm for direct solution of the dispatch problem when the units have quadratic cost characteristics. Mention the limitation of such direct solution method of dispatch problem. (12)

(b) The cost characteristics of, two units of a thermal plant are as follows : (13)

$C_1 = 465P_1 + 10.8P_1^2 + 1500$ Rs/hr

$C_2 = 375P_2 + 1.5P_2^2 + 1000$ Rs/hr

Limits on the capacities of the units are :

$0 \le P_1 \le 50$ MW ; $0 \le P_2 \le 100$ MW

If the load is to be shared most economically, determine the output of the two units when the plant loads are 25MW, 75 MW and 125 MW. Calculate the plant $\lambda$ in each case.

2.(a) Explain the term 'incremental cost of receipt power' of a thermal unit. With necessary derivation show how it is related to economic dispatch of a unit when transmission loss can not be neglected. Discus the physical significance of 'penalty factor' and 'incremental transmission loss'. (12)

(b) A small power system having three thermal power plants has the following loss coefficients : (6)

$B_{11} = 0.00005$, $B_{22} = 0.00009$, $B_{33} = 0.00013$, all other coefficients are zero.

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

$P_1 = 350$ MW, $P_2 = 300$ MW, $P_3 = 200$ MW

(c) From the transfer function model of LFC system show how integral control of the speed changer can nullify the steady state frequency error. (7)

3.(a) What do you understand by 'Base Point' and 'Participation Factor'? Clearly discuss their roles in real-time economic dispatch. (10)

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| (b) | What are the various costs and constraints considered in the unit commitment problem? Also explain briefly what you mean by feasible transition and the factors on which it depends.<br>With the help of a neat flow chart discuss clearly how the problem of unit commitment is solved by Dynamic Programming. | (15) |
| 4.(a) | With necessary derivation show on what factor the steady-state change in frequency in a single-area power system depends following a step change in load when the speed governors in the system are not operating. Also derive a transfer function model of speed governing system and show how the speed governors affect the steady state frequency error when the speed changer settings are fixed. Also show that the frequency error can be nullified by adjusting the speed changer settings. | (20) |
| (b) | A Power system area with capacity of 800 MW is running with a 650 MW at 50 Hz. Determine the change in steady state frequency following a step increase of load by 50 MW. The governor regulation is 5% and the load varies 1% for 1% change in frequency. | (5) |
| 5.(a) | Derive the transfer function model of a tie-line connecting two power systems and, hence, show how the LFC transfer function models of two areas can be connected to obtain the two-area LFC model. Also deduce the expressions for steady-state deviations in frequency and tie-line flow following a step load change in any one area. | (15) |
| (b) | Two 50 Hz power systems having capacity of 500 MVA and 1000 MVA are connected by a tie-line. The governor regulation and load damping factors are 0.02 p.u. and 1.0 p.u. respectively for both systems but with respect to their individual capacities. Calculate the steady-state change in frequency and tie-line power following a sudden increase in area 2 load by 100 MW. | (10) |
| 6.(a) | What do you mean by ACE in the context of load frequency control of multi-area power system? Also discuss its importance in nullifying the steady-state errors in frequency and tie-line flow, and show that it should be zero for the connected areas to nullify the steady state deviations in frequency and tie-line flow. | (8) |
| (b) | Discuss elaborately the short-term hydro-thermal scheduling problem and its solution. | (17) |