POWER SYSTEMS

***Time**: Three Hours*

***Maximum Marks**: 100*

Answer five questions, taking ANY TWO from Group A, any two from Group B and all from Group C.

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches. Unnecessary long answer may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Give classification of hydroelectric power plants. Draw a line diagram giving layout of a high head power plant and describe its working. 6

   (b) What are conventional and non conventional energy sources? Discuss salient features of conventional and non conventional methods of generation of electrical power. Mention their merits and demerits. 6

   (c) Prove that the average power in a hydel station is given by 8

   $$P = 3.14\eta KAFHx10^{-4}\ kW$$

   where A is the catchment area (in km^2); F, the annual rainfall (in mm); H, the effective head (in m); the plant efficiency; and K, the yield factor.

2. (a) Define each of the following and their effect on cost of electricity (i) load factor (ii) diversity factor (iii) demand factor (iv) plant use factor. 8

   (b) What do you understand by load curve? What are the information conveyed by load curve? 6

   (c) A generating station has a connected load of 43 MW and a maximum demand of 20 MW; the units generated being 61.5 x 10^6 kW per annum. Calculate: 6

   (i) demand factor

   (ii) load factor

3. (a) Draw schematic diagram of load frequency and excitation voltage regulators of a turbo generator system. 10

(b) Two generators rated 200 MW and 400 MW are operating in parallel. The drop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would a load of 600 MW be shared between them? What will be the system frequency at that load? Assume free governor operation. Repeat the problem if both governors have 5% drop. 10

4. (a) State and explain steady state stability, transient stability and dynamic stability. What do you understand by stability limits of the above? Discuss the factors that affect (i) steady state stability (ii) transient state stability of the system. 8

(b) A generator is connected to an infinite bus through two parallel lines. The induced emf of the generator is 1.2 p.u., the voltage of the infinite bus is 1 p.u., transient generator reactance X_d^i = 0.2 p.u. The reactance of each of the parallel lines 0.4 p.u. The system is operating in equilibrium with P_i = 1.5 p.u., when one of the lines is suddenly switched off. Determine whether the system will be stable or not. 6

(c) Find the maximum steady power capability of a system consisting of a generator equivalent reactance of 0.4 p.u. connected to an infinite bus through a series reactance of 1.0 p.u. The terminal voltage of the generator is held at 1.10 p.u. and the voltage of the infinite bus is 1.0 p.u. 6

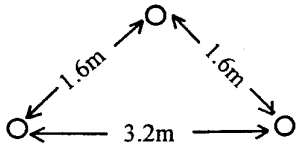
Group B

5. (a) Derive an expression for the internal inductance of a round and hollow conductor of inner and outer radii of r_1 and r_2 respectively. Also determine the expression for the inductance of a single phase line consisting of the hollow conductors described above with conductors spaced a distance D apart. 8

(b) What is meant by the terms GMD and GMR? What are bundled conductors? State the advantages of having bundled conductors in transmission systems. 6

(c) Determine the inductance of a 3 phase line operating at 50 Hz and conductors are arranged as shown in following figure. The conductor 6

diameter is 0.8 cm.



6. (a) Explain how transmission lines are classified into short, medium and long lines and explain their characteristics. 6

(b) Find the values of generalised circuit constants A, B, C and D of a transmission line in terms of Z (impedance) and Y (admittance) by nominal T-method and prove that AD – BC = 1. 8

(c) What is a receiving end power circle diagram? How can it be drawn? What information does it provide? 6

7. (a) What are the ACSR conductors and why are they preferred? Is sag a desirable or an evil for the transmission line? 6

(b) What are the electrical and mechanical characteristics required for a good insulator for use in HV transmission lines? 6

(c) Each line of 3 phase system is suspended by a string of 3 similar insulators. If the voltage across the line unit is 17.5 kV, calculate the line to neutral voltage. Assume that the shunt capacitance between each insulator and earth is 1/8 of the capacitance of insulator itself. Also find the string efficiency. 8

8. (a) Describe with a neat sketch, the construction of a 3-core, belted type cable. Discuss the limitations of such a cable. 10

(b) Show that the most economical size of conductor is a single core cable is obtained when radius of cable sheath (R) equals “er”, where e is the base of natural algorithm and r, the radius of conductor. 10

Group C

9. Answer the following in brief: 20

(i) Swing equation.

(ii) Advantages of underground transmission

(iii) Series compensation

(iv) Surge impedance loading

(v) Chemical and thermal pollution issues in a power plant and measures to resolve them.

(vi) Two-part tariff system for various types of consumers

(vii) Capacitance grading of cables

(viii) What are the causes of failure of insulators ?

(ix) How does rise in voltage at the receiving end of an open-circuited line depend upon the length of the line and system operating voltage ?

(x) What is critical clearing angle?

(Refer our course material for answers)