2021

ELECTRICAL ENGINEERING

PAPER-II

Time Allowed — 3 Hours   *Full Marks — 200*

If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining ones ignored.

Answers may be given either in **English** *or in* **Bengali** *but all answers must be in one and same language.*

The figures in the margin indicate for each question.
All symbols have their usual significance.

Answer *any five* questions.

1. (a) Describe the 'Synchronous Condenser' operations of Synchronous machine.   10

    (b) Can V-curve be plotted for alternator operation? How it differs from V-curve of a sychronous motor?   10

    (c) The rotating magnetic field of the stator and rotor of a 3-phase induction motor are stationary with respect to each other—Justify.   10

    (d) Explain why D. C. series motor is used in traction.   10

2. (a) A 220V DC shunt motor has an armature circuit resistance of 0.2Ω and field resistance of 110Ω. At no load the motor takes 5A and runs at 1500 r.p.m. If the motor draws 52A at rated voltage and rated load, calculate the motor speed and its roted shaft torque in Nm. The rotational losses at no-load and full load are the same. Neglect armature reaction.   12

    (b) In a 440/220 V, 50 Hz transformer, the total iron loss is 2500 watts. When the applied p.d. is 220 V at 25 Hz, the corresponding loss is 850 watts. Calculate the eddy current loss at normal frequecny and p.d.   8

    (c) (i) Why d.c. series motor should not be started at no load?

         (ii) Why starter is necessary to start a d.c. motor?

         (iii) Why is transformer core laminated?

         (iv) What is the purpose of short-circuit test on a power transformer?

         (v) Discuss the conditions for three-phase transformers running in parallel.   4×5=20

20946

Please Turn Over

3. (a) If stator impedance of an 3-phase induction motor is neglected, show from its equivalent circuit that maximum torque per phase is given by

$$T_{Sm} = \frac{1}{2\pi n_s} \cdot \frac{V_1^2}{2X_2}$$

and hence show that

$$\frac{T_S}{T_{Sm}} = \frac{2}{\dfrac{S_{mT}}{S} + \dfrac{S}{S_{mT}}}$$

For small value of slip occuring in the stable operating region 20

$$T_S = \frac{2T_{sm}}{S_{mT}} \cdot S$$

(b) What are ACSR conductors and why are they preferred over copper conductors for overhead lines? Why are the stranded conductors used? 10

(c) A 132 kV transmission line has the following data:

wt. of concuctor = 680 kg/km. Length of span = 260m. Ultimate strength = 3,100 kg; Safety factor = 2.

Calculate the height above ground at which the conductor should be supported. Ground clearance required is 10m. 10

4. (a) Determine the insulation resistance of a single core cable of length 3 km. and having conductor radious 12·5 mm insulation thickness 10 mm and specific resistance of insulation of $5 \times 10^{12}\,\Omega\text{-m}$. 10

(b) A 3-phase, 10,000 kVA, 11 kV alternator has a subtransient reactance of 8%. A 3-phase shortcircuit occurs at its terminals. Determine the fault current and fault MVA. 10

(c) Explain the following: 20

   (i) Differentiate between fixed and operating costs of power plants.

   (ii) Discuss two part tariff.

   (iii) What is necessity of power factor improvement?

   (iv) What information can be supplied by load curves?

   (v) What is the effect of increasing excitation of one of the two alternators operating in parallel?

5. (a) State and explain 'equal area' criterion in connection with transient stability analysis. What are the advantages of this method? What are its Limitations?   20

    (b) Single line diagram of a simple 4-bus system is given in Fig.-2. The relevant per unit line impedance are indicated on the diagram. The shunt admittances at the buses may be neglected. Determine Y_{bus} if buses 1 and 2 are not conected, as indicated by dotted line in Fig-2.   20
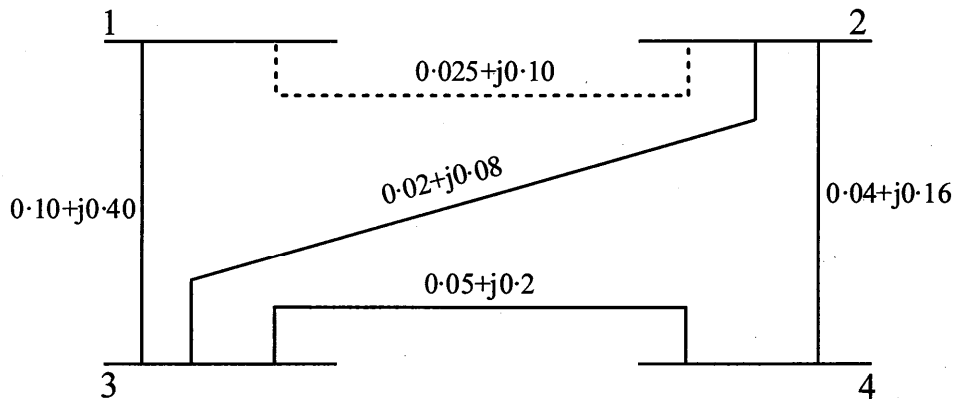

Fig-2

6. (a) Briefly discuss the advantages and the operational problems of HVDC transmission.   15

    (b) Explain the various methods of arc extinction of a circuit-breaker.   15

    (c) A 6·6 kV, 10 MVA star-connected alternator has a reactance of 2 ohms per phase and negligible resistance. Merz-Price protection is used for protection of winding. The neutral grounding resistance is 5 ohms. If only 10% of the winding is to be remain unprotected, determine the setting of relay.   10

7. (a) What is modulation? Why is modulation necessary in communication system?   10

    (b) What are the advantages of combined working of thermal power plant and hydro-electric plant? Discuss briefly the need for co-ordination of these plants in power system.   15

    (c) A thermal energy storage with a storage capacity Q_S of 300 kWh uses water as a storage medium. The water temperature in the storage varies between 80°C in fully charged state and 29°C in fully discharged state.

        Determine the required mass and volume of water as well as the mass and volume related energy density of storage.   10

    (d) What is photovoltaic cell or module?   5

8. (a) A lamp of 500 C.P. is suspended 4 metres above a horizontal surface. Calculate the illumination.

    10

    (i) directly below the lamp

    (ii) 3 meter away from the vertical axis

   (b) A slab of insulating material 150 cm^2 in area and 1 cm. thick is to be heated by dielectric heating. The power required 400 watts at 30 MHz. Material has permittivity of 5 and P.f. 0·05. Determine the voltage necessary, Absolute permittivity = 8·854×10^{-12} F/m (R.M.K.S).

    10

   (c) Explain with the help of a circuit diagram the working of a fluorescent lamp. Discuss the difference between electronic and magnetic blast. 20

   ―――――――