

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 the same language.

Answer any five questions.

1. (a) A six pole wave wound DC generator has 520 armature conductors. The armature current is 220 A. Find the armature reaction demagnetizing and cross magnetizing $A\tau/\text{Pole}$ if (i) brushes are placed along the GNA (ii) brushes are shifted by 5 electrical degrees from the GNA. 15
- (b) A 230 V DC shunt motor runs at 1200 rpm at no load and takes 4 Amp. The armature and shunt field resistances are 0.1Ω and 200Ω , respectively. Calculate speed of the motor when loaded to take 40 Amp if armature reaction, weakens the field by 4%. 15
- (c) Why brushes in DC machine are made of Graphite? 10
2. (a) A 5 kVA, single phase transformer has core loss of 40W and full load copper loss of 100 W. The daily load variations of the transformer is as follows:
7 AM – 1 PM = 3 kW at 0.6 p.f
1 PM – 6 PM = 2 kW at 0.8 p.f
6 PM – 1 AM = 6 kW at 0.9 p.f
1 AM – 7 AM = No load.
Determine all day efficiency of the transformer. 15
- (b) A 415V, four pole, 50Hz, three phase star connected induction motor has per phase stator impedance of $Z_1 = (0.06 + j0.2) \Omega$ per phase and rotor impedance referred to stator of $Z_2 = (0.07 + j0.4) \Omega$ per phase. The per phase magnetizing reactance is 10Ω and resistance representing core loss is 40Ω . The slip is 3.6%. Calculate (i) stator current and stator power factor and (ii) developed torque. 15

- (c) Derive the expression for the ratio of torque T at any slip to the maximum torque T_m of a three phase induction motor. 10
3. (a) A 100 MVA, 33 kV, 3-phase generating unit has a subtransmit reactance of 14%. The generator is connected to the motors through a transmission line and transformers as shown in Fig.-1. The motor have rated inputs 30 MVA, 20 MVA, 50 MVA at 30 kV and 20% subtransmit reactance. The 3-phase transformers are rated at 110 MVA, 32 kV/110 kV, Δ -Y with leakage reactance 7.5%. The line has a reactance of 50Ω selecting the generator circle. Determine the base quantities in the generator circle, determine the base quantities in other parts of the system and calculate the corresponding per unit values. 15

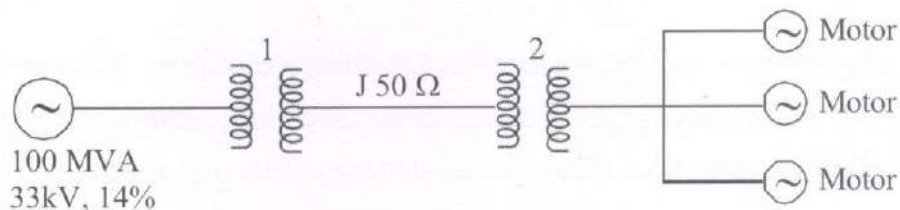


Fig.-1

- (b) A conductor with 2.5 cm diameter is passed centrally through a porcelain bushing $\epsilon_r = 4$ having internal and external diameters of 3 cm and 4 cm, respectively. The voltage between the conductor and an earthed clamp surrounding the porcelain is 20 kV rms. Determine whether corona will be present in the air space around the conductor. 15
- (c) Calculate the voltage at a distance of 200 m of a 300 m long distributor uniformly loaded at the rate of 0.75 A per metre. The distributor is fed at one end at 250 V. The resistance of the distributor (go and return) per metre is 0.00018Ω . Also find the power loss in the distributor. 10
4. (a) In a 33 kV overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 11% of self-capacitance of each insulator, find (i) the distribution of voltage over three insulators and (ii) string efficiency. 20
- (b) Determine the Inductance of a three phase symmetrical transmission line. 20
5. (a) Determine the A, B, C, D constants of a Medium transmission line. (use Nominal T model). 20

- (b) Determine the bus admittance matrix Y_{Bus} for a five bus system shown in Fig-2. Assume that the shunt admittance at the buses and mutual couplings between the lines are neglected. 20

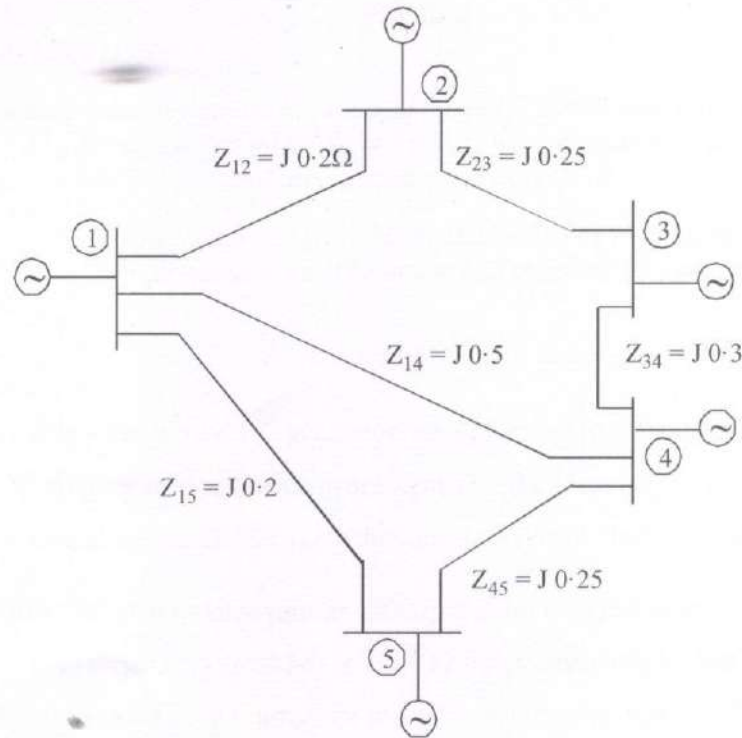


Fig.-2

6. (a) A 500 V series motor has an armature resistance of 0.4Ω and series field resistance of 0.3Ω . It takes a current of 100 A at a speed of 600 rpm. Find the speed of the motor if a diverter of resistance 0.6Ω is connected across the field, the load torque being constant. Neglect armature reaction and assume that flux is proportional to the current. 20
- (b) A resistance oven employing nichrome wire is to be operated from 220 V single phase supply and is to be rated at 16 kW. If the temperature of the element is to be limited to 1170°C and the average temperature of the charge is 500°C , find the diameter and length of the element wire. Radiating efficiency = 0.57, Emissivity = 0.9, Specific resistance of nichrome = $109 \times 10^{-8} \Omega\text{m}$. 20
7. (a) Explain in details the types of energy audit to be performed depends on which factors. Also explain the classification of energy audit. 20
- (b) Explain clearly the different instruments used for Energy Audit. 20
8. Write short notes on the following: 10×4=40
- What is a Sub-station? Classify Sub-station on the basis of service requirement.
 - Describe the operation of Distance or Impedance relay.
 - Write in details the desirable characteristics of Electrical tariff.
 - Explain with a neat diagram the Merz-price protection scheme of an alternator.