MSC(O)EE-II/19

2019

ELECTRICAL ENGINEERING-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.

The figures in the margin indicate marks for each question.

Answer may be written either in ***English*** *or in* ***Bengali*** *but all the answers must be in one and the same language.*

All symbols have their usual significances.

Answer *any five* questions.

1. (a) A 50 MVA, 11 kV, three phase synchronous generator was subjected to different types of faults. The fault currents are as follows:

LG fault — 4200 A

LL fault — 2600 A

LLL fault — 2000 A

The generator neutral is solidly grounded. Find the per unit values of three sequence reactances of the generator. 10

(b) A 6600 V, three phase alternator has a maximum rating of 2500 kVA and its reactance is 12·5%. It is equipped with Merz Price circulating current protection, which is set to operate at fault current not less than 200 amperes. Find what value of neutral earthing resistance leaves 10% of the winding unprotected. 15

(c) A 50 Hz transmission line is 280 km long. It has a total series impedance of (35 + j140) ohms and a shunt admittance of 930×10^{-6} mho. It delivers 40000 kW at 220 kV with 0·9 power factor lagging. Find the sending end voltage, voltage regulation, transmission efficiency and A, B, C, D constants by the nominal T-method approximation. 15

2. (a) A single core lead sheath cable has a conductor of 10 mm diameter and two layers of different insulating materials, each 10 mm thick. Relative permittivities are 3 (inner) and 2·5 (outer). Calculate the potential gradient at the surface of the conductor when the potential difference between the conductor and the lead sheath is 60 kV. 10

(b) Define Transient Recovery Voltage. Draw the Transient Recovery Voltage Curve and also derive an expression for Rate of Rise of Recovery Voltage (RRRV). 10

(c) A 50 Hz, 3-phase synchronous generator has an inductance per phase of 1·65 mH and its neutral is grounded. It feeds a line through the circuit breaker. Total stray capacitance to ground of the generator and circuit breaker is 0·0022 μF. A fault occurs just beyond the circuit breaker, which opens when the symmetrical short circuit current is 7000A (rms). Determine the following:

(i) Natural frequency of oscillations

(ii) Peak value of Transient Recovery Voltage (TRV)

(iii) Time at which the peak value of TRV occurs

(iv) Maximum rate of rise of TRV 12

(d) Write advantages and disadvantages of SF_6 circuit breaker. 8

3. (a) A single phase transformer with secondary voltage of 230 V, 50 Hz delivers power to load R = 10 ohm through a half wave controlled rectifier circuit. For a firing angle delay of 60°, determine the rectification efficiency, form factor, voltage ripple factor, transformer utilization factor and PIV of thyristor. 15

(b) The speed of a separately excited DC motor is controlled below base speed by type-A chopper. The supply voltage is 220V DC. The armature circuit has $R_a = 0{\cdot}5$ ohm and $L_a = 10$ mH. The motor constant is 0·1 V/rpm. The motor drives a constant torque load requiring an average current of 30A. On the assumption of continuous armature current, calculate:

(i) The range of speed control and

(ii) The range of duty cycle 15

(c) A single-phase 230V, 1 kW heater is connected across single-phase 230V, 50 Hz supply through a diode. Calculate the power delivered to the heater element. Find also the peak diode current and input power factor. 10

4. (a) Draw the equivalent circuit of an arc furnace and performance characteristics of a typical arc furnace. Derive the condition for the maximum output. 4+4+10=18

(b) A low frequency induction furnace, whose secondary voltage is maintained cosntant at 10 Volts, takes 400 kW at 0·6 power factor when the hearth is full. Assuming the resistance of the secondary circuit to vary inversely as the height of the charge and reactance to remain constant, find the height up to which hearth should be filled to obtain maximum heat. 12

(c) A slab of insulating material, 150 cm^2 in area and 1 cm thick is to be heated by dielectric heating. The power required is 400W at 30 MHz. Material has relative permittivity of 5 and of 0·05. Absolute permittivity = $8{\cdot}854 \times 10^{-12}$ F/m. Determine the necessary voltage. 10

5. (a) Explain Maximum Power Point Tracker (MPPT). 5

(b) Explain what are the methods used to overcome the fluctuating power generation of windmill. 10

(c) A 200W filament lamp is suspended at a height of 5 metres above working plane and gives uniform illumination over an area of 4 metre diameter. Determine the illumination on the working plane. Given efficiency of the reflector is 50% and efficiency of the lamp is 0·89 W/CP. 10

(d) Explain what is meant by stroboscopic effect. What causes stroboscopic effect in fluorescent lamp? Describe one method for avoiding stroboscopic effect. 7+4+4=15

6. (a) Define what is meant by Amplitude Modulation (AM). Derive the relevant expressions for AM wave. 20

(b) Explain what is meant by frequency shift keying. 5

(c) Draw and explain PAM generation system. 15

7. (a) A 220V DC shunt motor has armature and field resistance of 0·2 ohm and 220 ohm respectively. The motor is driving a constant load torque and running at 1000 rpm, drowing 10A current from the supply. Calculate the new speed and armature current if an external armature resistance of 5 ohm is inserted in the armature circuit. Neglect armature reaction and saturation. 20

(b) The O.C. and S.C. test data are given below for a single phase, 5 kVA, 200/400V, 50 Hz transformer:

O.C. test (on L.V. side) : 200V, 1·25A, 150W

S.C. test (on H.V. side) : 20V, 12·5A, 175W

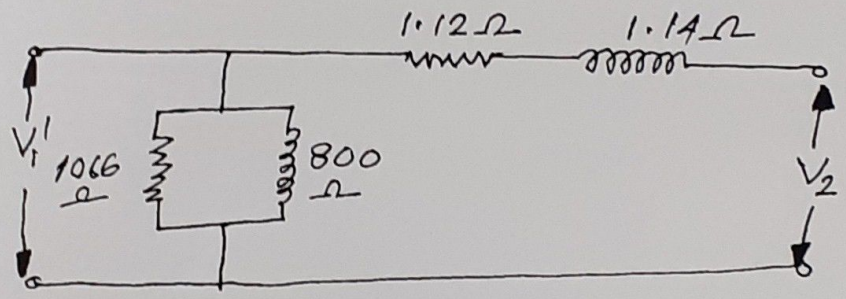

Fig: Equivalent circuit referred to HV side.

Calculate the following: 20

(i) The efficiency of the transformer at 75% loading with load power factor = 0·7

(ii) At what load or kVA the transformer is to be operated for maximum efficiency? Calculate the maximum efficiency.

(iii) Regulation of the transformer at full load 0·8 power factor lagging

(iv) What should be the applied voltage to the LV side when the transformer delivers rated current at 0·7 power factor lagging, at a terminal voltage of 400V?

8. (a) A three phase induction motor has a starting torque of 100% and a maximum torque of 200% of the full load torque. Find: 20

(i) Slip at maximum torque

(ii) Full-load slip

(iii) Rotor current at starting in pU of full load current

Neglect stator impedance.

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

(c) The rotating field of the stator and rotor are stationary with respect to each other — Justify. 10
