

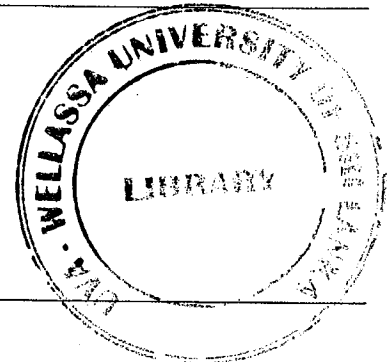
Instructions to candidates

Duration: Two (02) hours

Number of questions: Four (04)

Mark allocation: 100 marks

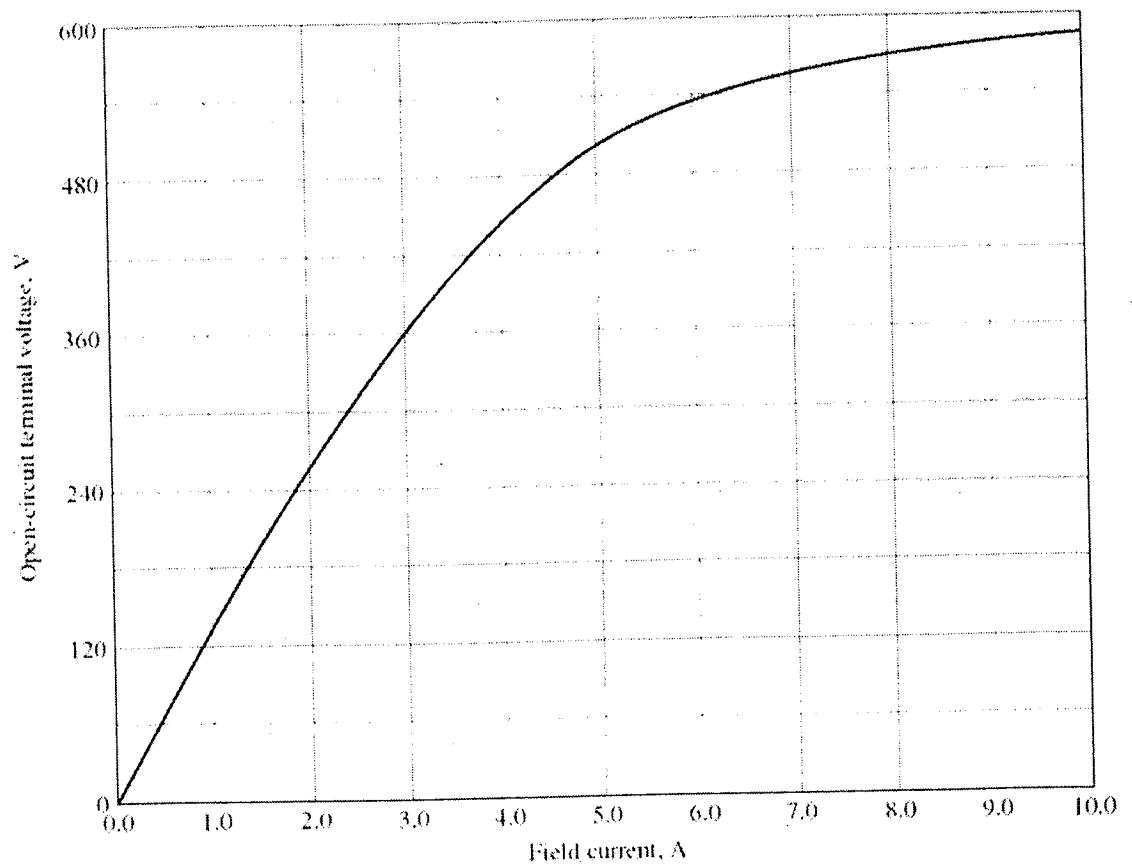
Answer all questions



- 1.
- a. Explain how, high current and high voltage measurements are possible through low range instruments with the use of current transformer and potential transformer. ( Use diagrams where necessary)
- (10 Marks)**
- b. A 20 kVA 8000/480 V, single phase transformer has the following resistances and reactances:  $R_p = 32 \Omega$ ,  $R_s = 0.05 \Omega$ ,  $X_p = 45 \Omega$ ,  $X_s = 0.06 \Omega$ ,  $R_c = 250 \text{ k}\Omega$ ,  $X_M = 30 \text{ k}\Omega$ . The excitation branch impedances are given referred to the high voltage side of the transformer. Note that all symbols have their usual meaning.
- i. Find the approximate equivalent circuit of this transformer referred to the high voltage side.
- (05 Marks)**
- ii. If this transformer is supplying rated load at 480 V and 0.8 PF lagging, calculate the input voltage of the transformers. What is the Voltage regulation ?
- (05 Marks)**
- iii. What is the transformer efficiency under the above loading conditions?
- (05 Marks)**
2. A 480 V, 50 Hz, delta-connected, 4 pole synchronous generator has the OCC shown in below figure. This generator has a synchronous reactance of  $0.1 \Omega$  per phase, and armature resistance of  $0.015 \Omega$  per phase. At full-load, the machine supplies 1200 A at 0.8 PF lagging. Under full load conditions, the friction and windage losses are 40 kW and the core losses are 30 kW
- i. What is the speed rotation of the magnetic field in rpm?

(05 Marks)

- ii. How much is the field current that must be supplied to the generator to make the terminal voltage 480V at no load?  
(05 Marks)
- iii. If the generator is now connected to the load and the load draws 1200 A at 0.8 PF lagging, how much field current will be required to keep the terminal voltage to 480V? What is the voltage regulation of this generator?  
(05 Marks)
- iv. How much power is now generator is supplying? How much power is supplied to the generator by the prime mover? What is the efficiency of the generator?  
(05 Marks)
- v. If the generator is now connected to a load drawing 1200 A at 0.8 PF leading, how much field current will be required to keep  $V_T = 480$  V and what is the voltage regulation of the generator?  
(05 Marks)



3.

- a. What are the type of losses taking place in an induction motor? Draw the power flow diagram indicating how the power flows through an induction motor.

(05 Marks)

- b. A 208 V, two pole, 60 Hz Y – connected wound-induction motor is rated at 15 hp. Its equivalent circuit components are  $R_1 = 0.200 \Omega$ ,  $R_2 = 0.120 \Omega$ ,  $X_M = 15 \Omega$ ,  $X_1 = 0.410 \Omega$ ,  $X_2 = 0.410 \Omega$   $P_{mech} = 250 \text{ W}$ ,  $P_{misc} \approx 0$ ,  $P_{core} = 180 \text{ W}$ . Note that all symbols have their usual meaning. For a slip of 0.05, find;

- i. The line current  $I_L$

(05 Marks)

- ii. The air gap Power  $P_{AG}$

(05 Marks)

- iii. The induced torque  $\tau_{ind}$

(05 Marks)

- iv. Load torque  $\tau_{load}$

(05 Marks)

4.

- a. With the usual notation obtain the rms values of induced emf in a transformer to be

$$E = 4.44 f \phi_m N$$

Consider  $N_p$  as number of turns in the primary side the Number of turns in the secondary side -  $N_s$  - is the Number of Secondary Windings The magnetic flux  $\phi$ , let  $\phi_m$  be the maximum value of the flux and  $f$  be the frequency of the supply.

(06 Marks)

- b. A 100 kVA, 4000 V/200 V, 50 Hz single-phase transformer has 100 secondary turns. Determine;

- i. The primary and secondary current

- ii. The number of primary turns

- iii. The maximum value of the flux

(07 Marks)

- c. Including the effect of armature resistance, draw the phasor diagram of a salient polesynchronous generator supplying a lagging load. Define all the notation you have used.

(05 Marks)

- d. Using the phasor diagram drawn in part c. prove that,

$$\tan \delta = \frac{I_a X_q \cos \theta - I_a r_a \sin \theta}{V_\phi + I_a X_q \sin \theta - I_a r_a \cos \theta}$$

(07 Marks)