

Instructions to candidates

Duration: Two (02) hours

Number of questions: Four (04)

Mark allocation: 100 Marks

Answer all questions

1.
 - a. Prove that the generated voltage and induced torque for a dc machine can be written as $E_A = K\phi\omega_m$ and $\tau_{ind} = K\phi I_A$ respectively, where ϕ is the flux of the machine. (5 marks)
 - b. A 50 hp, 240 V, 1200 r/min dc shunt motor without compensating windings has an armature resistance (including the brushes and interpoles) of 0.06Ω . Its field circuit has a total resistance $R_F + R_{adj}$ of 40Ω , which produces a no-load speed of 1200 r/min. There are 1200 turns per pole on the shunt field winding, and the armature reaction produces a demagnetizing magnetomotive force of $1200 A \cdot \text{turns}$ at a load current of 200 A. The magnetization curve of this machine is shown in Figure 1 below.

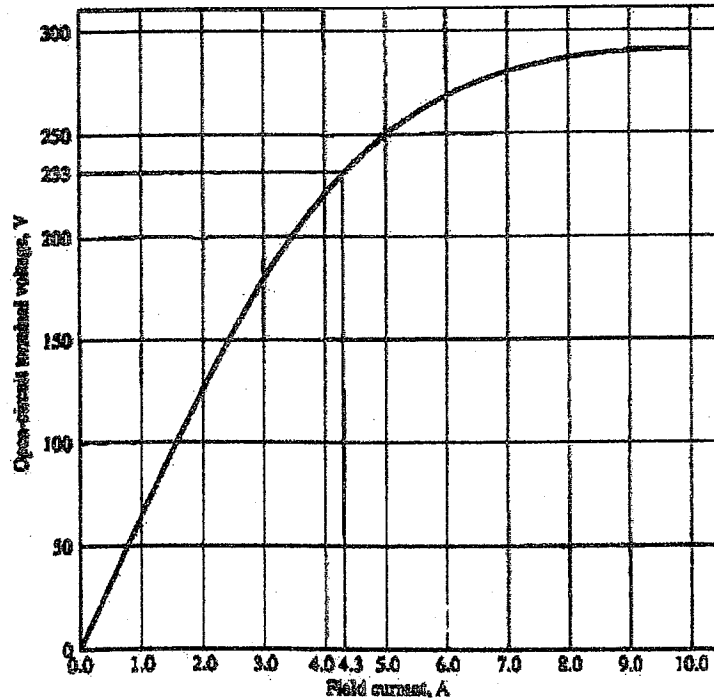


Figure 1

Find the speed of this motor when its input current is 200 A. How does its speed differ when compared with compensating windings at a load current of 200 A?

(20 marks)

2.

A single-phase power system consists of a 480 V 60 Hz generator supplying a load $Z_{load} = 4 + j3\Omega$ through a transmission line of impedance $Z_{line} = 0.18 + j0.24\Omega$. Answer the following questions about this system.

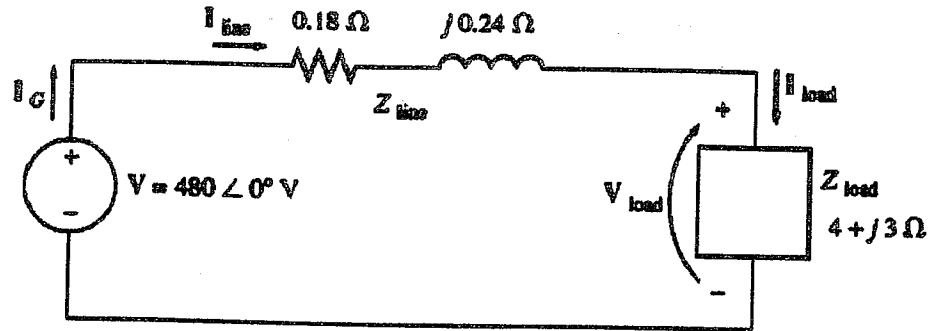


Figure 2

- a) If the power system is as described above in Figure 2, what will the voltage at the load be? And what will the transmission line losses be?

(10 marks)

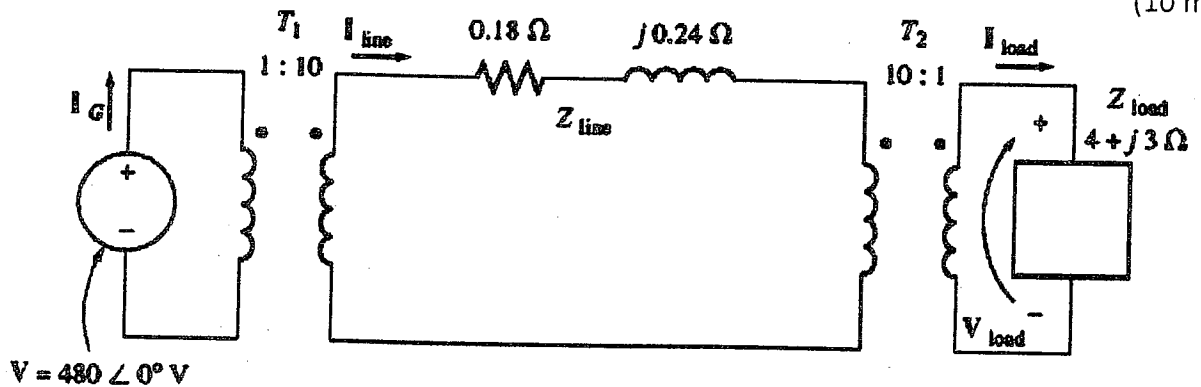


Figure 3

- b) Suppose a 1: 10 step-up transformer is placed at the generator end of the transmission line and a 10: 1 step-down transformer is placed at the load end of the line (Figure 3). What will the load voltage be now? What will the transmission line losses be now?

(15 marks)

3.

The equivalent circuit impedances of a 20 kVA, 8000 V/240 V, 60 Hz transformer are to be determined. The open-circuit test and the short-circuit test were performed on the primary side of the transformer, and the following data were taken:

Open-circuit test (on Primary)	Short-circuit test (on Primary)
$I_{OC} = 0.214 A$	$I_{SC} = 2.5 A$

Find the impedances of the approximate equivalent circuit referred to the primary side, and sketch that circuit.

(25 marks)

4.

- a) What are salient pole and nonsalient pole construction of a synchronous machine rotor? (3 marks)
- b) What are the methods of supplying dc power to the rotor? (3 marks)
- c) Draw a schematic diagram of a brushless exciter circuit and briefly explain its operation. (6 marks)
- d) Draw phasor diagrams of a synchronous generator at lagging and leading power factor. (6 marks)
- e) Draw the power flow diagram of a synchronous generator and indicate losses. (6 marks)

