AUB/FEA/ECE	
ELECTRIC MACHINES AND POWER FUNDAMENTALS (EECE 370)	
INSTRUCTORS: PROFS. CHAABAN, JABR, AND KARAKI	QUIZ 2, CLOSED BOOKS, 90MIN.
DATE: DECEMBER 21, 2011	NO PENALTY
STUDENT NAME:	STUDENT I.D.:

Unmarked Versions

Solve the following questions or problems;
Provide your answers in pencil on the attached Scantron card;
This question sheet must be returned with the Scantron card;
Programmable calculators are not allowed;

1. The machine components that are explicitly used to provide a path for the current in or out of the rotating parts of a synchronous machine are:
   a. Brushes and slip rings.
   b. Rotor shaft.
   c. Rotor winding.
   d. Stator winding.

2. The direction of rotation of a 3-phase ac motor could be reversed by:
   a. Reconnecting the winding into 'delta'.
   b. Disconnecting one of the phases.
   c. Interchanging the connections of all 3 phases.
   d. Interchanging the connections of 2 of the 3 phases.
   e. None of the above.

3. As the field of a synchronous machine is increased to a point beyond saturation, the synchronous reactance will:
   a. Remain constant.
   b. Increase linearly.
   c. Decrease.
   d. Increase exponentially.

4. If the inductive load connected to an ac generator is increased while the field current and the speed are kept constant, then as a result:
   a. The load current(I_a) and the terminal voltage (V_t) increase.
   b. I_a and V_t decrease.
   c. I_a decreases and V_t increases.
   d. I_a increases and V_t decreases.

5. During the synchronization (paralleling) process of a synchronous generator, adjustment of the frequency of the generator is achieved by:
    a. Controlling the field excitation of the generator.
    b. Controlling the speed of the prime mover.
    c. Controlling the synchronous reactance of the generator.
    d. None of the above.

6. For a synchronous generator, the torque angle is the angle between the phasors of the:
    a. Induced voltage and the armature current.
    b. Induced voltage and the per- phase terminal voltage.
    c. Terminal voltage and the armature current.
    d. Field current and the armature current.

An 8- kVA, 120/480- V transformer has a full load efficiency of 98% when operating at unity power factor. The device is re-connected as an autotransformer to supply 480- V load from a 600- V supply. Answer questions 7 and 8.

7. The kVA rating as an autotransformer is:
    a. 1.3 kVA.
    b. 20 kVA.
    c. 40 kVA.
    d. 50 kVA.

8. The efficiency of the autotransformer when operating at full load with 0.95 lagging power factor is:
    a. 95.42%.
    b. 96.76%.
    c. 98.00%.
    d. 99.57%.

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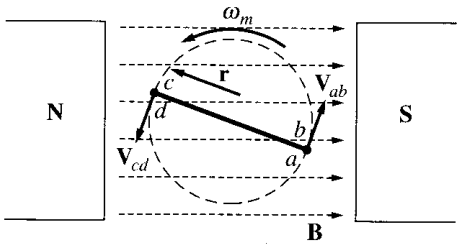
9. A three-phase transformer bank is to handle 30 kVA and have a 8000/230-V voltage ratio. Find the rating of each individual transformer in the bank (high voltage, low voltage, and apparent power) if the transformer bank is connected Y-Δ.
    a. (4619 V, 230 V, 10 kVA)
    b. (8000 V, 132.8 V, 10 kVA)
    c. (4619 V, 230 V, 90 kVA)
    d. (8000 V, 132.8 V, 90 kVA)
    e. (4619 V, 132.8 V, 30 kVA)

10. Three 4.8 kVA, 380 / 120 V, single-phase transformers are to be used to form a three-phase step-down transformer (high-voltage side is the primary, low voltage side is the secondary). For a Δ-Y connection, the rated primary line current and rated secondary line current are:

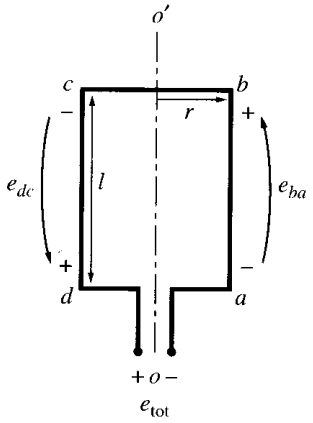
    a. 12.6 A and 69.3 A
    b. 21.9 A and 40.0 A
    c. 12.6 A and 40.0 A
    d. 21.9 A and 69.3 A
    e. 4.2 A and 13.3 A

The simple loop rotating in the uniform magnetic field shown below has the following characteristics:

B = 1.5 T to the right r = 0.1 m
l = 0.2 m ω_m = 300 rad/s



B is a uniform magnetic field, aligned as shown.



Refer to this data for the following two questions.

11. Find the voltage $e_{tot}(t)$ induced in this rotating loop.

    a. 3 sin(300t) V
    b. 6 sin(300t) V
    c. 12 sin(300t) V
    d. 18 sin(300t) V
    e. 24 sin(300t) V

12. Assume that a 2 Ω resistor is connected as a load across the terminals of the loop. Calculate the induced torque on the loop.

    a. 0.72 $\sin^2$(300t) N.m
    b. 0.54 $\sin^2$(300t) N.m
    c. 0.36 $\sin^2$(300t) N.m

d. $0.18 \sin^2(300t)$ N.m

e. $0.09 \sin^2(300t)$ N.m

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13. Determine the speed of rotation of the magnetic field in a three-phase AC machine of 32 poles operating at a frequency of 400 Hz.

    a. 400 revolutions per second

    b. 200 revolutions per second

    c. 100 revolutions per second

    d. 50 revolutions per second

    e. 25 revolutions per second

14. A three-phase, Δ-connected, eight-pole winding is installed in 48 slots on a stator. There are 100 turns of wire in each slot of the windings. All coils in each phase are connected in series. The flux per pole in the machine is 0.02 Wb, and the speed of rotation of the magnetic field is 900 rpm. What is the resulting terminal voltage of this stator?

    a. 4265 V

    b. 8530 V

    c. 17061 V

    d. 34121 V

    e. 12795 V

A synchronous generator with rated voltage of 380 V and rated power 200 kVA at 0.85 PF lagging is used in the *following 3 problems*. The generator frequency is 50 Hz, it has four poles and is Y-connected. At rated conditions the core losses of this generator are 7 kW and its friction and windage losses are 9 kW. The open circuit and short circuit characteristics are shown in Figure 1.

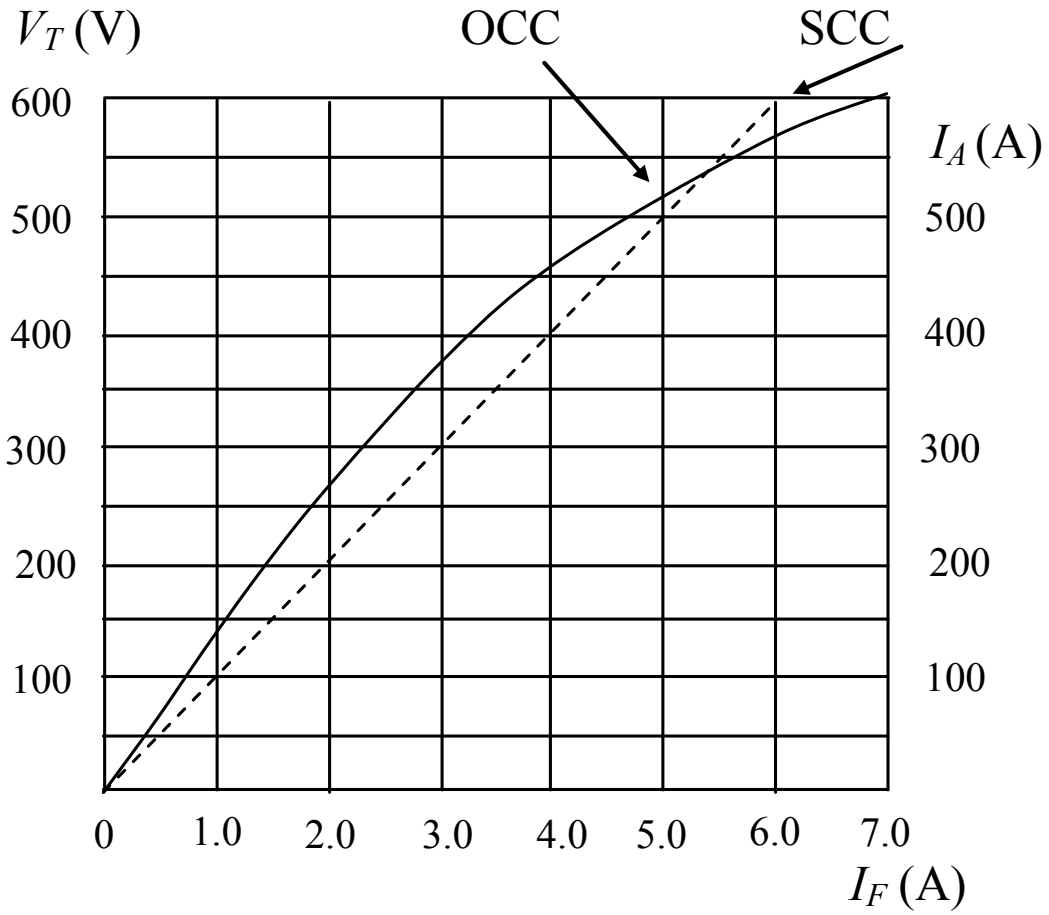

Figure 1: Open circuit and short circuit characteristics for Problem 15.

15. The synchronous reactance of this generator in ohms per phase at rated armature current is:

    a. 1.256 Ω
    b. 1.439 Ω
    c. 0.720 Ω
    d. 0.628 Ω
    e. 0.854 Ω

16. A dc resistance test is carried out on the terminals of phases A and B with phase C open. The applied dc voltage is 25V and the current measured is 300A. What is the approximate value of the armature resistance?

    a. 0.021 Ω
    b. 0.042 Ω
    c. 0.028 Ω
    d. 0.053 Ω

e. 0.014 Ω

17. If the machine is operating at rated voltage and current conditions, what is the efficiency of the machine if its armature resistance is 0.06 Ω?
    a. 81.4 %
    b. 87.5 %
    c. 86.5 %
    d. 89.4 %
    e. 83.9 %

A synchronous generator is rated at 600 V, 500 kVA, 0.85 PF lagging, and 50 Hz. The generator has four poles and is Y-connected with a synchronous reactance X_S= 0.58Ω per phase and an armature resistance R_A= 0.046Ω per phase. At rated conditions the core losses of this generator are 13 kW and its friction and windage losses are 18 kW, respectively. Data of this generator is used in the following 3 problems.

18. If the generator is operating at rated conditions and the load is suddenly removed, what will its terminal voltage be?
    a. 969 V
    b. 1186 V
    c. 866 V
    d. 1076 V
    e. 812 V

19. What is the induced torque of the generator if it is operating at rated conditions?
    a. 3700 Nm
    b. 1403 Nm
    c. 2909 Nm
    d. 4516 Nm
    e. 2144 Nm

20. The field current of the generator is set so that its terminal voltage is 900V at no-load. What is the terminal voltage of this generator if it is loaded with the rated current at 0.9 PF lagging?
    a. 655 V

b. 604 V

c. 552 V

d. 497 V

e. 446 V