KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ENGINEERING

BSc. (Mechanical Engineering) Second Semester Examination, 2018)

EE 252 : ELECTRICAL ENGINEERING MACHINE

(Third Year)

MAY, 2018 **TWO AND HALF HOURS**

INSTRUCTIONS FOR CANDIDATES:

1. Answer **ALL** questions in Section A and any **ONE** question in section B
2. Circle the letter corresponding to your answer to a given question on the paper and shade the same letter on the scannable sheet provided
3. *Indicate your Centre Name on top of the Answer booklet*

SECTION A

A 20 kVA 2500 / 250 V, 50HZ, single phase transformer gave the following test results

Open circuit test (on low voltage side) - 250 V , 1.4A 105 watts.

Short circuit test (on high voltage side) - 104 V , 8A 320 watts.

Use this information to answer questions 1-8.

1. Calculate the no-load power factor.
   a) 0.4 b) 0.5 c) 0.3 d) none of the above
2. Calculate the value of short–circuit impedance, Z_{eq}, of the transformer.
   a) 10Ω b) 13 Ω c)16Ω d) none of the above
3. Calculate the short–circuit leakage reactance X_{eq}, of the transformer.
   a) 9Ω b) 12 Ω c)15Ω d) none of the above
4. Calculate the efficiency of the transformer when it is delivering full load at unity power factor.
   a) 97.91% b) 99.89% c) 93.28% d) none of the above
5. Calculate the efficiency of the transformer when delivering half load at 0.8 p.f. lagging.
   a) 95.89% b) 97.73% c) 98.06% d) none of the above
6. Calculate the load at which maximum efficiency of the transformer occurs.
   a) 17.52kVA b) 11.46kVA c) 13.42kVA d) none of the above
7. Calculate the maximum efficiency of the transformer at unity power factor.
   a) 98.89% b) 95.73% c) 99.06% d) none of the above
8. Calculate the maximum efficiency of the transformer at 0.8 power factor.
   a) 98.89% b) 95.73% c) 99.06% d) none of the above

A 100 kVA, 2200/400 V, single-phase transformer is shown to have an iron loss of 850 W when open-circuit tested. From a short-circuit test the effective resistance in the secondary was found to be 0.0144 Ω. ***Use this information to answer questions 9-12.***

9. Calculate the effective resistance of the transformer referred to the primary side.
   a)0.436Ω b) 0.546Ω c) 0.685Ω d) 0.578Ω
10. Calculate the total electrical loss of the transformer.
    a) 900W b) 1000W c) 800W d) 1050W
11. Calculate the efficiency of the transformer when it is delivering full load at unity power factor.
    a) 89.5% b) 97.89% c) 98.28% d) 96.89%
12. Calculate the efficiency of the transformer when delivering half load at 0.8 p.f. lagging.
    a) 97.89% b) 97.38% c) 98.56% d) 96.89%

A solenoid relay is operated from a 220-V, dc supply and the 1000-turn coil resistance is.5.5 kΩ The core diameter of the relay is 20 mm and the gap length is 1.5 mm, the armature being stationary. The gap faces may be taken as parallel and the permeability of the ferromagnetic parts as very high. Take $\mu_o=4\pi\times10^{-7}$. ***Use this information to answer questions 13-17.***

13.Determine the current that will flow through the relay coil .

a)0.04A b)0.004A c)0.05A d)None of the above

14.Determine the mmf of the magnetic system

a)40.0 At b) 80.0 At c) 120.0 At d)None of the above

15. Determine the air gap flux density

a)0.0107Wb/m^2 b) 0.00107Wb/m^2 c) 0.107Wb/m^2 d)None of the above

16. Determine the coil inductance

a)0.804 H b) 0.084H c) 0.656H d)None of the above

17. Determine the pull on the armature.

a)0.95N b) 0.88N c) 0.69N d)None of the above

18. A long shunt compound D.C. motor runs at full-load speed of 1000 rpm. If the current through its series field windings is caused to be zero, then its full-load speed

a. becomes more than 1000 rpm b) remains 1000 rpm

c) becomes less than 1000 rpm d) becomes 1100 rpm

19. In a d.c. series generator, with increase in load, the terminal voltage

a) decreases b) remains unchanged

c) Increases d) varies with drooping characteristics

20. Armature winding is one in which working

a) flux is produced by field current b) e.m.f. is produced by the working flux

b) flux is produced by the working e.m.f. d) e.m.f. is produced by the leakage flux

An eight –pole armature is wound with 480 conductors. The magnetic flux and speed are such that average emf generated in each conductor is 2.2V and each conductor is capable of carrying a full load current of 100A. ***Use this information to answer questions 21 to 24***

21. Find the terminal voltage on no load in volts if the armature is lap-connected.

a) 162 b) 153 c) 144 d) 132

22. Find the output current on full load in amperes if the armature is lap-connected.

a) 800 b) 750 c) 700 d) 650

23. Find the terminal voltage on no load in volts if the armature is wave-connected.

a) 556 b) 544 c) 528 d) 506

24. Find the output current on full load in amperes if the armature is wave-connected.

a) 200 b) 180 c) 160 d) 140

A 600 V d.c motor has an armature circuit resistance of 0.14 Ω. At no load, when the motor is running at 800rev/ min, the armature current is 12 A. The full load armature current is 225A. ***Use this information to answer questions 25 and 26.***

25. Find the full load speed in rev/ min when the field pole flux is constant.
a) 840 b) 800 c)760 d) 720

26. Find the full load speed in rev/ min when the field pole flux is reduced to 80% of its original value.
a) 1200.45 b) 1150.04 c) 1050.08 d) 950.07

An eight –pole armature is wound with 480 conductors. The magnetic flux and speed are such that average emf generated in each conductor is 2.2V and each conductor is capable of carrying a full load current of 100A. ***Use this information to answer questions 27 to 29***

27.Find the terminal voltage on no load in volts if the armature is lap-connected.
a) 162 b) 153 c) 144 d) 132

28. Find the output current on full load in amperes if the armature is lap-connected.
a) 800 b) 750 c) 700 d) 650

29. Find the terminal voltage on no load in volts if the armature is wave-connected.
a) 556 b) 544 c) 528 d) 506

A motor which has a combined series field and armature resistance of 0.85 Ω, runs at 1000rev/min, and draws 20 A from a 250-V source. ***Use this information to answer questions 30 to 32.***

30. Find the developed torque in N.m.
a) 44.50 b) 42.24 c)40.80 d) 38.42

31. Find the developed torque in N.m.
a) 44.50 b) 42.24 c)40.80 d) 38.42

32. Find the full speed in rev/ min if 3.75 -ohm resistor is connected in series with the motor and it draws 20 A from a 250-V supply.
a) 710 b) 678 c) 540 d) 403

A 250 V d.c shunt machine has an armature resistance of 0.5Ω and a shunt field resistance of 125Ω, both values at working temperature. The iron, windage and frictional losses in the machine amount to 750 W. When the machine is running as a motor at full load, the current taken from the supply is 52A.

Use this information to answer questions 33 -36.

33. Calculate the power taken by the motor from the supply at full load.
a) 15.7kW b)13.0 kW c) 11.9kW d) 9.5kW

34. Calculate the armature copper loss at full load.
a) 1.25kW b)1.73 kW c) 1.81kW d) 2.39kW

35. Calculate the total losses in machine at full load.
a) 2.50kW b)3.73 kW c) 2.81kW d) 2.29kW

36. Calculate the efficiency of the motor at full load.
a) 83.80% b) 80.77% c) 95.5% d) 75.2%

37. Which of the following is **NOT TRUE** about an electrical machine?
a) It converts electrical energy into mechanical energy.
b) It consists of stationary and rotationary parts.

c) Both rotor and stator can be excited.

d) It is only the stator that is always excited.

38. Which of the following describes a critical field resistance of self excited d.c. machines?

a)It is the maximum total resistance of the field circuit above which self excitation will not be achieved.

b)It is the total resistance in the armature and field circuits

c)Its value decreases with increasing speed of the machine.

d)It is the total resistance of the field circuit when the machine is operating at full load.

39. Which of the following methods is used to control the speed of a d.c. motor below its rated value?

a. By means of a motor-generator set.

b. By means of a divertor in field circuit.

c. By connecting the field windings in parallel.

d. By varying the number of turns of the field windings.

40. Which of the following is **NOT** among the requirements for a d.c. machine to be self excited?

a. The critical field resistance must not be exceeded.

b. The speed of the machine must be below a critical value.

c. There should be a residual magnetic field in the machine.

d. The residual magnetic field and the generated field must add up.

41. Which of the following describes a transformer?

a. It converts electrical energy into mechanical energy

b. It converts one voltage level to another at the same frequency

c. It is a device with a considerable low efficiency

d. It produces ohmic losses when operating under no load

42. Which of the following statement is **NOT TRUE** of a transformer

a. Its primary winding is the one that is always connected to the supply.

b. Its secondary winding is the one that is always connected to the load

c. It has an oil conservator which regulates the temperature of the primary and secondary windings

d. It can be used to step down a voltage of a system.

43. Which of the following **is TRUE** about a star /delta starter of an induction motor?

a. It increases the starting current to about 57%.

b. It reduces the starting torque to about 33.33%.

c. It is very simple to operate.

d. It helps to increase voltage in the system.

44. Which of the following statements is TRUE?

a. Direct on-line starting is allowed for all induction motors.

b. Direct on-line starting is allowed for all motors with ratings above 4 kW.

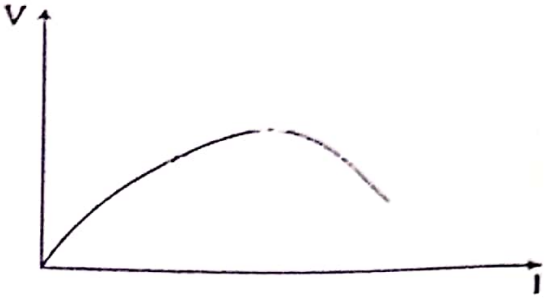
c. Direct on-line starting is allowed for motors up to 2 kW.

d. Direct on-line starting is even not allowed for motors up to 1.5 kW.

45. Which of the statements is TRUE about a wound rotor induction motor?
a. It can be made to produces maximum torque at starting.
b. When external resistors are connected to the rotor, the starting torque is reduced.
c. The starting current increases when external resistors are connected to the rotor.
d. It is the most robust induction machine.

46. Which of the following is TRUE about armature reaction?
a. It causes reduction of the terminal voltage of d.c. generator.
b. It gives rise to increase in the generated emf of a d.c. machine.
c. It occurs only in d.c. machines.
d. It is maximum at the geometric neutral of d.c. machines.

47. The graph below is an external characteristic of a d.c. generator. Name the type of generator which has this characteristic.



a) Separately excited b) Series wound c) Shunt wound d) Compound wound

48. Which of the following **is NOT** a method of controlling the speed of a d.c. motor?
a. By means of a diverter in the field circuit.
b. By means of a resistor in the armature circuit.
c. By interchanging the polarities of the armature terminals.
d. By means of an autotransformer and a rectifier.

A 3- phase , 4 pole , 440 -V , 50 HZ , star connected induction motor, operates at 1425 rev/min on full load and has the following parameters per phase: R_1=0.04 Ω , X_1=0.15Ω , R'_2=0.05 Ω and X'_2=0.15Ω . Neglect the magnetizing current.

Use this information to answer questions 49-60.

49. Calculate the synchronous speed in radians / second
a) 104.7 b) 157.1 c) 53.1 d) 163.3

50. Calculate the percentage slip at full load .
a) 8% b) 5% c) 10% d) 2%

51. Calculate the starting current of the motor.
a) 766.26 A b) 811.06 A c) 466.76 A d) 578.23A

52. Calculate the full load current of the motor.
a) 234.69 A b) 221.81A c) 166.46 A d) 478.33A

53.Calculate the total power input to the rotor circuit at full load..

a) 238.10kW b) 122.76kW c) 165.25kW d) 119.90kW

54. Calculate the full load torque of the motor.

a) 939.54Nm b) 1400.70Nm c) 876.89 Nm d) 1051.80Nm

55. Calculate the percentage slip at which a maximum torque can occur in the motor.

a) 18.7% b) 16.5% c) 20.9% d) 12%

56. Calculate the starting torque of the motor

a) 500.19 Nm b) 650.76 Nm c) 560.62 Nm d) 582.70 Nm

57. Find the motor rotor copper loss at full load.

a) 6.35kW b) 7.40kW c) 8.27kW d) 9.96kW

58.Find the power taken from the supply by the motor at full load if the stator losses amount to 1.6 kW

a) 166.85kW b) 211.89kW c) 319.16kW d)136.11kW

59.Find the efficiency of the motor at full load, if the friction and windage losses amount to 0.6 kW.

a)97.6% b) 89.9% c)95.7% d) 93.72%

60.What will be the current taken from the supply at full load if the motor runs at a power factor of 0.89 lagging?

a) 220.10A b) 245.99A c) 182.27A d) 276.90A

61.The direction of rotation of a three-phase induction motor can be changed by

a. By connecting the winding in star.
b. By completely changing the sequence of the leads to the windings of the motor.
c. By interchanging any two of leads to the windings of the motor.
d. By completely changing the sequence of the leads to the windings of the motor so that a delta connection is obtained.

62.How does the speed of a shunt motor change when a resistor is connected in series with the shunt field and shaft load remains the same?

e.The speed of the motor will decrease because the field current has decreased.
f. The speed of the motor will not change because the shaft load is constant.
g.The speed of the motor increases because the field current has decreased.
h.The speed of the motor increases but soon be decreases

63.Which of the following explains why the armature current of a shunt motor decreases as the motor accelerates?

a.The high speed of the motor will cause the flux in the motor to decrease.
b.The supply voltage decreases because the back emf has increased.
c.The current decreases because the motor cannot take up any load.
d.The current decreases because the back emf has increased

64.Which of the following is **not true** about a squirrel cage motor?

a) It has a multiple phase rotor.

b)The presence of external resistors in the rotor circuit gives rise to high starting torque.

c)It is more efficient than the slip ring induction motor.

d)It is more robust than the slip ring induction motor.

65.DC series motor should never be switched on at no load, because

a) the field current is initially zero

b) the speed becomes dangerously high

c) the motor does not pick up

d) it will take long to accelerate

66. The volt-ampere equation for a long shunt compound motor is given by

a) $V_t = E_a + I_a r_a$ b) $V_t = E_a - I_a r_a$

c) $V_t = E_a + I_a(r_a + r_s)$ d) $V_t = E_a + I_a r_a + I_L r_s$

The armature of a d.c machine has a resistance of 0.1 Ω and is connected to a 230 V supply.

Use the above information to answer questions 67 and 68

67.Calculate the generated E.M.F when it is running as a generator giving 80A.

a)218V b)265V c) 238V d)None of the above

68.Calculate the generated E.M.F when it is running as a motor taking 60A.

a)190V b)245V c)224V d) None of the above

69.A four pole motor is fed at 440V and takes an armature current of 50A . The resistance of the armature circuit is 0.28 Ω .The armature winding is wave –connected with 888 conductors and the useful flux per pole is 0.023Wb. Calculate the speed.

a)567rev/min b)626rev/min c)545 rev/min d)None of the above

70.Which of the following explains why the armature current of a shunt motor decreases as the motor accelerates?

a) The high speed of the motor will cause the flux in the motor to decrease.

b) The supply voltage decreases because the back emf has increased.

c) The current decreases because the motor cannot take up any load.

d) The current decreases because the back emf has increased

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