KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ENGINEERING

BSc. (Mechanical Engineering) End of Second Semester Examination

EE 252 : ELECTRICAL ENGINEERING MACHINES

MARCH, 2018

Time allowed**: ONE HOUR**

INSTRUCTIONS FOR CANDIDATES:

1. Answer **ALL** questions.

2. Circle your answer on the question paper and on the Scannable sheet.

3**.** Indicate your **index number** on the question paper.

CAUTION: DO NOT TAKE AWAY ANY EXAMINATION MATERIAL PROVIDED TO YOU , UNLESS YOU ARE TOLD TO DO SO.

1. The volt-ampere equation for a long shunt compound generator is given by

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

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

2. Armature winding is one in which working

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

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

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 3 and 4.

3. 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

4. Caculate 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

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

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 $\mu_o=4\pi\times10^{-7}$.

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

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

6. Determine the mmf of the magnetic system

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

7. Determine the air gap flux density

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

8. Determine the coil inductance

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

9. Determine the pull on the armature.

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

10. 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

h) becomes more than 1000 rpm b)remains 1000 rpm

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

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

i) decreases b) remains unchanged

c) Increases d) varies with drooping characteristics

12. Armature winding is one in which working

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

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

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 9 and 10.

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

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

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

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

15. A four pole d.c 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.

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

16. A d.c. motor runs at 900rev/min off a 460 V supply. Calculate the approximate speed when the machine is connected across a 200V supply. Assume the new flux is to be 0.7 of the original flux

m) 367rev/min b)648 rev/min c)559 rev/min d) None of the above

17. A D.C. shunt motor is running with a certain load. The effect of adding an external resistance in the field circuit is to

n) reduce the motor speed b) reduce the armature current of the motor

c) increase the motor speed d)stop the motor

18. A three phase 50 Hz , 4-pole ,squirrel cage induction motor has its stator rewound for 6 poles without any alteration in the rotor .The motor will now run at the speed

o) less than 1000 rpm. b)1500 rpm c)less than 3000 rpm d)zero rpm

19. If a 3-phase, 4-pole slip ring induction motor runs at 1440 rpm, then the slip is

p) 0.03 b)0.04 c)0.05 d)None of the above

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

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

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

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

t) The current decreases because the back emf has increased

A 3- phase , 4 pole , 440 -V , 50 HZ , star connected induction motor, operates at 1450 rev/min on full load and has the following parameters per phase: $R_1=0.05\ \Omega$, $X_1=0.12\Omega$, $R'_2=0.04\ \Omega$ *and* $X'_2=0.14\Omega$. *Neglect the magnetizing current.*

Use the above information to answer questions 17 and 18.

21. Calculate the synchronous speed in radians / second

u) 150.0 b)163.3 c)157.1 d)None of the above

22. Calculate the percentage slip at full load.

v) 8% b)5% c) 3% d) None of the above

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

w) By connecting the winding in star.

x) By completely changing the sequence of the leads to the windings of the motor.

y) By interchanging any two of leads to the windings of the motor.

z) By completely changing the sequence of the leads to the windings of the motor so that a delta connection is obtained.

20 A shunt motor supplied at 230V runs at 900rev/min when the armature current is 30A .The resistance of the armature circuit is 0.4 Ω. Calculate the resistance required in series with the armature to reduce the speed to 600rev/min, assuming that the armature current is then 20A

aa) 6.35 Ω b)4.90 Ω c)3.84 Ω d)None of the above

21.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.

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

a) the field current is initially zero b) the motor does not pick up

c) the speed becomes dangerously high d) it will take long to accelerate

2. 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)$V_t = E_a + I_a(r_a + r_s)$ $d\ )\ V_t = E_a + I_a r_a + I_L r_s$

3. The rotor of an induction motor cannot run at synchronous speed because if it does so then

a) rotor e.m.f will be zero b) rotor current will be zero

c) rotor torque would be zero d) all of the above

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 the above information to answer questions 25 to 28

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

a)162 b) 153 c)132 d)None of the above

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

a)800 b)750 c) 700 d)None of the above

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

a)556 b)544 c)528 d)None of the above

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

a. 200 b)180 c)140 d)None of the above

29. A D.C shunt generator when driven without any excitation showed an open circuit voltage of 12 volts .When the field winding was excited, the voltage dropped to zero . It happened because

a) The field resistance was higher than the critical resistance

b) There was break in the armature circuit c) Field winding was wrongly connected

d) There was no residual magnetism in the field circuit

30. A D.C shunt motor runs at a rated speed if its field circuit gets open –circuited, then soon after this the motor speed would tend to

a) decrease b) remain ungagged c) increase d) fluctuate around its previous speed

FORMULA SHEET

$$I_2 = \frac{E_2}{\sqrt{R_2^{\,2} + X_2^{\,2}}}$$

$$I_2' = I_1 = \frac{V_{1ph}}{\sqrt{(R_1 + \frac{R_2'}{s})^2 + (X_1 + X_2')^2}}$$

$$P_{rotor} = \frac{3I_2 R_2}{s} \quad = \frac{3I_2'^2 R_2'}{s} = T\omega_s$$

$$T = \frac{3V_{1ph}^{\,2} R_2'}{s\omega_s[(R_1 + \frac{R_2'}{s})^2 + (X_1 + X'_2)^2]}$$

$$T_{\max} = \frac{3V_{1ph}^{\,2}}{2\omega_s(R_1 + \sqrt{(R_1^{\,2} + (X_1 + X_2')^2})}$$

$$s_{T\max} = \frac{R_2'}{\sqrt{(R_1^{\,2} + (X_1 + X_2')^2}}$$

$$\eta = \frac{n\,S\cos\theta}{n\,S\cos\theta + P_0 + n^2 P_{sc\ full\ load}}$$

$$V.R._{p.u} = \frac{V_{sc}\cos(\theta_{sc} \pm \theta_{pf})}{V_1}$$

$$V = E_{arm} - I_a R_a - I_L R_{ser} \qquad I_f = \frac{V_L + I_L R_{ser}}{R_f}$$

$$V = E_{arm} - I_a(R_a + R_{ser}) \qquad I_f = \frac{V_L}{R_f}$$

$$V = E_{arm} \pm I_a(R_a + R_{ser})$$

$$\eta = \frac{V_L I_L}{V_L I_L + I_a^{\,2} R_a + I_f V_f + I_{ser}^{\,2} R_{see} + coreloss + friction + windage}$$

All symbols have their usual meanings.