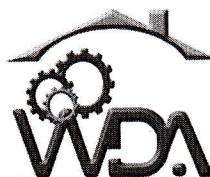ELC - Electrotechnics
T001
Thursday, 23/11/2017
08:30 – 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2017, TECHNICAL AND PROFESSIONAL STUDIES

EXAM TITLE: ELECTROTECHNICS

OPTION: Electricity (ELC)

DURATION: 3 hours

INSTRUCTIONS:

The paper is composed of the following sections:

**Section I: Eighteen (18) compulsory** questions.   **55 marks**

Section II: Attempt **any three (3)** out of five questions.   **30 marks**

Section III: Attempt **any one (1)** out of three questions.   **15 marks**

Note:

Every candidate is required to carefully comply with the above instructions. Penalty measures will be applied on their strict consideration

01. For any two alternating signals, what do you understand by **"leading signal"?**   **1 mark**

02. State the laws of electrostatics?   **3 marks**

03. What do you understand by an over-excited synchronous motor?

2 marks

04. A multiple plate capacitor has 10 plates, each of area 10 square cm and separation between 2 plates is 1 mm with air as dielectric. Determine the energy stored when voltage of 100 volts is applied across the capacitor.   **3 marks**

05. Calculate the distribution factor for a 36 slots, 4-pole, single layer three-phase winding.   **3 marks**

06. (a) Define the following expressions and mention their units: **3 marks**
      1) Self-inductance,
      2) Mutual inductance
  (b) Derive an expression for the energy stored in an inductor of self-inductance 'L' Henry carrying the current of 'I' amperes.   **1 mark**

07. For the circuit shown in the figure below;
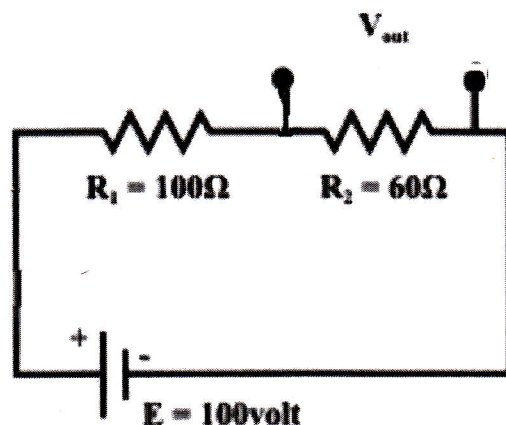

Calculate V_{out} across 60Ω resistor, ignoring the internal resistance of the source *E*. Use voltage division.   **3 marks**

08. A 12-pole, 3-phase alternator driven at a speed of 500 r.p.m. supplies power to an 8-pole, 3-phase induction motor. If the slip of the motor, at full-load is 3%, calculate the full-load speed of the motor.   **3 marks**

09. Express the difference between "linear" and "nonlinear" circuits?

3 marks

10. An autotransformer has a coil with total number of turns $NCD = 200$ between terminals **C** and **D**. It has got one tapping at **A** such that the number of turns $NAC = 100$ and another tapping at **B** such that the number of turns $NBA = 50$. As shown in figure.
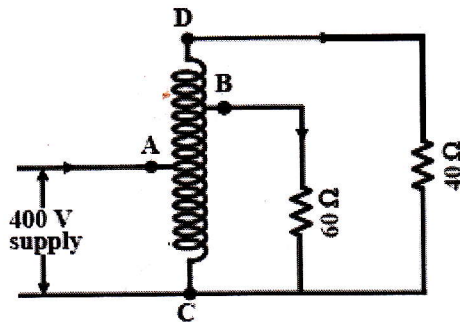
Calculate the current and voltage for each resistance of the circuit, when 400 V supply is connected across AC.

4 marks

11. Calculate the speed at which a 2-pole machine must rotate to obtain a voltage having frequency of 50Hz.

1 mark

12. An alternating voltage e = 200 sin 314t is applied to a device which offers an ohmic resistance of 20 Ω to the flow of current in one direction, while preventing the flow of current in opposite direction. Calculate for the current over one cycle:

     a) RMS value,

     b) average value and

     c) Form factor.

3 marks

13. Explain the following terms related to magnetic circuits:

     a) Reluctance

     b) Magnetomotive force

2 marks

14. What do you understand by the term 'back e.m.f.'?

1 mark

15. A d.c. motor connected to a 460-V supply has an armature resistance of 0.15 Ω. Calculate:

     (i) The value of back e.m.f. when the armature current is 120 A.

     (ii) The value of armature current when the back e.m.f. is 447.4V.

4 marks

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16. A resistance of 10 Ω is connected in series with two resistances each of 15 Ω arranged in parallel. What resistance must be shunted across this parallel combination so that the total current taken shall be 1.5 A with 20 V applied?

5 marks

17. A single-phase transformer has 400 primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm². If the primary winding be connected to a 50-Hz supply at 520 V, calculate:

(i) The maximum value of flux density in the core.
(ii) The voltage induced in the secondary winding.

4 marks

18. Two batteries **A** and **B** are connected in parallel and load of 10 Ω is connected across their terminals. **A** has an e.m.f. of 12 V and an internal resistance of 2 Ω ; **B** has an e.m.f. of 8 V and an internal resistance of 1 Ω. Use Kirchhoff 's laws to determine:

a) the values and directions of the currents flowing in each of the batteries;
b) The value and direction of current in the external resistance.
c) Also determine the potential difference across the external resistance.

6 marks

Section II. Choose and answer any three (3) questions only.   **30 marks**

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19. At 25 Nm, the armature current of the generator is 16A at this value of torque. If the shunt field regulator is adjusted so that the flux is reduced by 15 per cent, the torque increases to 35 Nm. Determine the armature current at this new value of torque.   **10 marks**

20. The power supplied to a three-phase induction motor is 32kW and the stator losses are1200W. If the slip is 5 per cent, determine (a) the rotor copper loss, (b) the total mechanical power developed by the rotor, (c) the output power of the motor if friction and windage losses are 750W, and (d) the efficiency of the motor, neglecting rotor iron loss.   **10 marks**

21. A single phase a.c. generator supplies the following loads :
(i) Lighting load of 20 kW at unity power factor;
(ii) Induction motor load of 100 kW at p.f. 0·707 lagging;
(iii)Synchronous motor load of 50 kW at p.f. 0·9 leading;

Calculate the total kW and kVA delivered by the generator and the power factor at which it works.   **10 marks**

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22. An overhead 3-phase transmission line delivers 5000 kW at 22 kV at 0·8 p.f lagging. The resistance and reactance of each conductor is 4·Ω and 6 Ω respectively.

Determine:

      (i) Sending end voltage

      (ii) percentage regulation

      (iii) transmission efficiency.   **10marks**

23. A series motor runs at 800 rev/min when the voltage is 400V and the current is 25A. The armature resistance is 0.4_ and the series field resistance is 0.2. Determine the resistance to be connected in series to reduce the speed to 600 rev/min with the same current.   **10 marks**

Section III. Choose and answer any one (1) question.   **15 marks**

24. a) State the Power Factor (PF)

    b) Describe the main factors of Power Factor that play an important role in AC circuits both **Intensity** and **Power dissipation** using formulae **of power in three phase AC circuit and Single phase Ac circuit**

    c) In case of Low Power Factor what will be happened?

    d) Describe the three causes of low Power factor

    e) How to improve PF?   **15 marks**

25. With drawing, name the missing parts indicated by numbers on DC Machine.
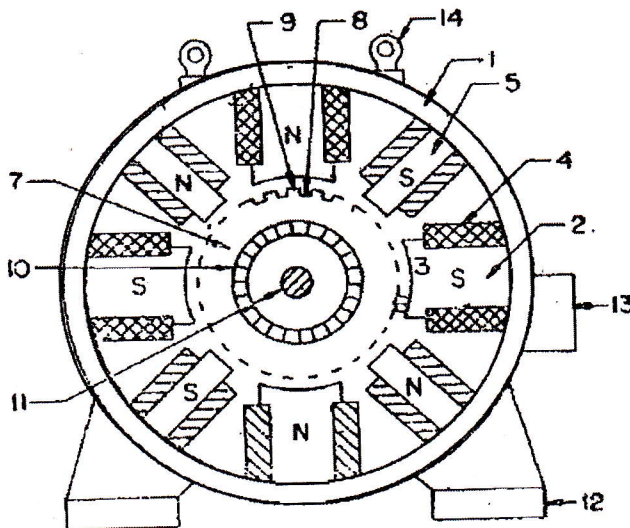
    15 marks

26. Initially a DC shunt motor shown on figure having $r_a = 0.5\Omega$ and $R_f = 220\Omega$ is running at 1000rpm drawing 20 A from 220 V supply. If the field resistance is increased by 5%.Calculate the new steady state armature current and speed of the motor. Assuming that the load torque to be constant.
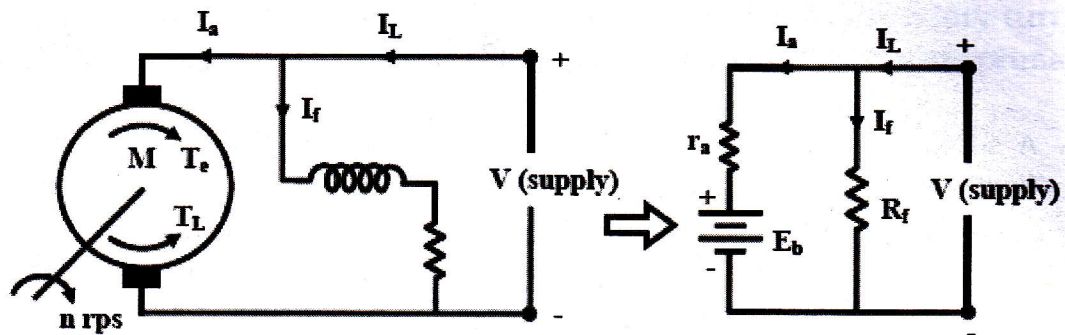

Figure : D.C shunt motor

15 marks

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