ELC – Electrotechnics

T034

Thursday, 31/10/2013

8:30 – 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2013; TECHNICAL AND PROFESSIONAL TRADES

EXAM TITLE: **Electrotechnics**

OPTION: **Electricity (ELC)**

DURATION: **3hours**

INSTRUCTIONS:

The paper contains **Three (3)** Sections:

Section I: Seventeen **(17)** questions, all **Compulsory**. **55marks**

Section II: Five **(5)** questions Choose and answer any **Three (3)**. **30marks**

Section III: Three **(3)** questions Choose and answer any **one (1)**. **15marks**

Section I: Attempt all the 17 questions **55marks**

01. State the laws of electrostatics. **3marks**

02. In practice, earth is chosen as a place of zero electric potential because it: **2marks**

(a) is non-conducting
(b) is easily available
(c) keeps losing and gaining electric charge every day
(d) has almost constant potential

03. Calculate the distance of separation between two electrons (in vacuum) for which the electric force between them is equal to the gravitation force on one of them at the earth surface. Mass of electron = 9.1×10^{-31} kg,

charge of electron = 1.6×10^{-19} C. **3marks**

04. A conductor material has a free-electron density of 10^{24} electrons per m^3. When a voltage is applied, a constant drift velocity of 1.5×10^{-2} meter/second is attained by the electrons. If the cross-sectional area of the material is 1 cm^2, calculate the magnitude of the current. Electronic charge is 1.6×10^{-19} coulomb. **2marks**

05. A rectangular carbon block has dimensions 1.0 cm × 1.0 cm × 50 cm.

What is the resistance measured between :
(i) the two square ends? **2marks**
(ii) Between two opposing rectangular faces / Resistivity of carbon at 20°C is 3.5×10^{-5} Ω-m? **1mark**

06. Describe the Fleming's left-hand rule. **3marks**

07. What is the effect of rise in temperature on resistance of materials? **3marks**

08. A 1500 turn coil is uniformly wound around an iron toroid of uniform cross sectional area of 5 cm^2. Calculate the e.m.f and flux density produced if the resulting flux is 0.2 mWb when the coil current is 0.75 A. **2marks**

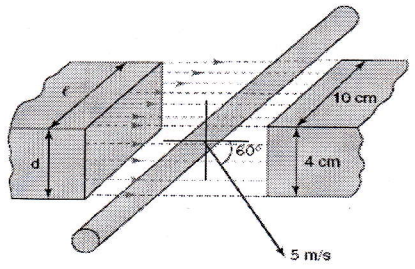
09. State the laws of parallel currents. **3marks**

10. 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 is 1.5 A with 20 V applied? **4marks**

11. Determine the torque established by the armature of a four-pole D.C. motor having 774 conductors, two paths in parallel, 24 milli-webers of pole-flux and the armature current is 50 Amps. **2marks**

12. An alternating voltage is represented by the expression $v = 35 \sin (314.2\ t)$ volt. Determine,
(**a**) The maximum value, (**b**) the frequency, (**c**) the period of the waveform, and
(**d**) the value 3.5 ms after it passes through zero, going positive. **4marks**

13. A conductor is moved at a velocity of 5 m/s at an angle of 60° to a uniform magnetic field of 1.6 mWb. The field is produced by a pair of pole pieces, the faces of which measure 10 cm by 4 cm. If the conductor length is parallel to the longer side of the field, calculate the e.m.f induced; see Figure. **3marks**



14. A voltage of 120 V at 50 Hz is applied to a resistance R in series with a capacitance C. The current drawn is 2 A, and the power loss in the resistance is 100 W. Calculate:

(i) The resistance; **1mark**

(ii) The capacitance; **2marks**

(iii) The power factor; **1mark**

(iv) The phase angle; **1mark**

15. If a single phase transformer has 500 turns on its primary and 1000 turns on its secondary.

a. Determine its turn's ratio. Is it step-up or step-down? **1mark**

b. If its primary voltage is $e_p = 25 \sin \omega t$ V, what is its secondary voltage? **1mark**

c. Sketch the waveforms. **2marks**

16. A 220-V d.c. shunt machine has an armature resistance of 0.5 Ω. If the full-load armature current is 20 A, find the induced e.m.f. when the machine acts as:

(i) Generator **(ii)** motor (Shunt current is negligible) **4marks**

17. When the three identical star connected coils are supplied with 440V, 50Hz, 3 phase supply, the wattmeter connected between phase R and the neutral reads 6kW and the ammeter connected in R-phase reads 30A assuming RYB phase sequence, find:

i) Resistance and reactance of the coil; **4marks**

ii) Reactive power of 3 phase load; **1mark**

Section II: Choose and Answer any Three (3) questions 30marks

18. a) What does a capacitor consist of? Does current pass through it? **2marks**

b) The capacitance of a capacitor formed by two parallel metal plates each of 200 cm^2 in area separated by a dielectric 4 mm thick is 0.0004 microfarads.
A p.d. of 20,000 V is applied.
Calculate:

(i) The total charge on the plates; **2marks**

(ii) The potential gradient in V/m; **2marks**

(iii) Relative permittivity of the dielectric; **2marks**

(iv) The electric flux density; **2marks**

19. The resistance of the field winding of a shunt generator is 200 Ω. When the machine is delivering 80 kW the generated e.m.f and terminal voltage are 475 V and 450 V respectively. Calculate:

(a) The armature resistance, **5marks**

(b) The value of generated e.m.f when the output is 50 kW, the terminal voltage then being 460V. **5marks**

20. A resistance of 20 ohm, inductance of 0.2 H and capacitance of 150 μF are connected in series and are fed by a 230 V, 50 Hz supply. Find X_L, X_C, Z, Y, p.f., active power and reactive power. **10marks**

21. A 3-phase, star-connected alternator supplies a load of 10 MW at p.f. of 0.85 lagging and at 11 kV (terminal voltage). Its resistance is 0.1 ohm per phase and synchronous reactance is 0.66 ohm per phase. Calculate the line value of e.m.f. generated. **10marks**

22. A 3-phase, delta/star connected 11,000/440 V, 50 Hz transformer takes a line current of 5 amp, when secondary Load of 0.8 lagging p.f. is connected. Determine each coil current and output (kws) of transformer. **10marks**

Section III: Choose and Answer any one (1) question 15marks

23. A 1100-V, 50-Hz delta-connected induction motor has a star-connected slip-ring rotor with a transformation ratio of 0.263. The rotor resistance and standstill leakage reactance are 0.012 ohm and 0.25 ohm per phase respectively. Neglecting stator impedance and magnetizing current determine.

(i) The rotor current at start with slip-rings shorted; **4marks**

(ii) The rotor power factor at start with slip-rings shorted; **1mark**

(iii) The rotor current at 4% slip with slip-rings shorted; **4marks**

(iv) The rotor power factor at 4% slip with slip-rings shorted; **1mark**

(v) The external rotor resistance per phase required to obtain a starting current of 100 A in the stator supply lines. **5marks**

24. An inductive coil, having resistance of 8 Ω and inductance of 80 mH, is connected in series with a capacitance of 100μ*F* across 150 V, 50 Hz supply. Calculate, and express the answers in both polar and rectangular forms.

(a) The current, **9marks**

(b) The power factor, **1mark**

(c) The voltages drops in the coil and capacitance respectively. **5marks**

25. **(a)** What are the disadvantages of low lagging power factor? **6marks**

(b) A 3-phase, 50-Hz, 3,000-V motor develops 600 h.p. (447.6 kW), the power factor being 0.75 lagging and the efficiency 0.93. A bank of capacitors is connected in delta across the supply terminals and power factor raised to 0.95 lagging. Determine capacitance of each capacitor. **9marks**