

ELC – Electrotechnics

T041

Thursday, 30/10/2014

8:30 - 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY



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**ADVANCED LEVEL NATIONAL EXAMINATIONS, 2014
TECHNICAL AND PROFESSIONAL TRADES**

EXAM TITLE: ELE - Electrotechnics

OPTION: Electricity (ELC)

DURATION: 3hours

INSTRUCTIONS:

The paper is composed of **three (3) main Sections:**

Section **I:** Fifteen **(15)** questions, all **Compulsory.**

55marks

Section **II:** Five **(5)** questions, **Choose any Three (3).**

30marks

Section **III:** Three **(3)** questions, **Choose any One (1).**

15marks

SECTION I. FIFTEEN (15) COMPULSORY QUESTIONS.

01. An electron in electrical device travels at $3 \times 10^7 \text{ m/sec}$ perpendicular to a field of flux density $18.5 \mu\text{T}$. Calculate the force exerted on the electron in the field.

2marks

02. A dc shunt motor has a resistance of 0.5Ω at stand-still. It is to be connected to a 120V supply.

Calculate: The value of the resistance of a face plate starter to limit the starting current to 40A.

3marks

03. Calculate the speed in rpm of an ac generator with 24 poles, to produce a voltage with a frequency of 50 Hz.

2marks

04. A 25Ω resistor is connected in series with an inductance, a capacitor and an ammeter across 30V variable frequency supply. When the frequency is 450Hz, the circuit is at its maximum value of 0.8A and the potential difference across the capacitor is 160V.

Calculate: The capacitance of the capacitor.

3marks

05. A shunt generator supplies a 25kW load at 250V through cables of resistance $R = 150 \text{ m}\Omega$. If the field winding resistance $R_f = 60 \Omega$ and the armature resistance, $R_a = 50 \text{ m}\Omega$,

Determine: (a) The terminal voltage and

(b) The e.m.f generated in the armature.

5marks

06. A shunt generator has a field resistance of 80Ω when the generator delivers 8kW; the terminal voltage is 160V, while the generator E.M.F is 190V. Determine the armature resistance.

4marks

07. A capacitor C is connected in series with a 45Ω resistor across a supply of frequency 50Hz. A current of 4A flows and the circuit impedance is 60Ω

Calculate: (a) The value of capacitance (C)

(b) The supply voltage

(c) The phase angle between the supply voltage and current

(d) The p.d across the resistor

(e) The p.d across the capacitor.

6marks

08. The conductors of the stator of a generator have a length of 0.5m. The conductors move through a magnetic field of 0.8 teslas at a speed of 68 m/s. Find the amount of induced voltage in each conductor.

2marks

09. A 3-phase induction motor runs at almost 1200rev/min at no-load and 1400rev/min at full load when supplied with power from 60Hz, 3-phase line

(a) How many poles has the motor?

(b) Calculate the percentage slip at full load and the corresponding frequency of the motor voltages

(c) What is the corresponding speed of the motor field with respect to motor?

(d) What is the corresponding speed of the motor with respect to the stator? **5marks**

10. A 3800WDC Motor operates from a 110VDC source with losses of 600W under rated full-load conditions, the full-load speed is 900rpm. Under no load conditions, the speed is 960rpm. Find the source current, the efficiency with full load, and the speed regulation. **3marks**

11. A coil of 400 turns is wound uniformly on a ring of non-magnetic material. The ring has a mean circumference of 50cm and a uniform cross-sectional area of 5cm^2 . If the current in the coil is 6A.

Calculate: (a) The magnetic field strength

(b) The flux density

(c) The total magnetic flux in the ring. **3marks**

12. Describe a transformer in its simplest form. **3marks**

13. A 380V (line to line) is applied to three star connected identical impedances each consisting of a 3Ω resistance in series with 2Ω inductance reactance. Calculate the line current and total power supplied. **5marks**

14. A closed magnetic circuit of a magnetic material contains a 8cm long path of cross-sectional area 1.5cm^2 and a 3cm path of cross-sectional 1cm^2 . A coil of 300turns is wound around the 8cm length of the circuit and a current of 0.6A flows. Determine the flux density in the 3cm path, if the relative permeability of the magnetic material is 800. **6marks**

15. A load has impedance $10 + j5\Omega$ and is fed by a voltage of 100V. Calculate the current and power consumed by the load? **3marks**

SECTION II. ATTEMPT ANY THREE (3) QUESTIONS.

16. Three impedance are connected in series across a 60V, 10Kz supply, a resistance of 10Ω , a coil of inductance $150\mu\text{H}$ and 8Ω , and a 12Ω resistor in series with a $0.5\mu\text{F}$ capacitor.

Calculate: a. The circuit current

b. The circuit phase angle

c. The voltage drop across each impedance. **10marks**

17. The 220-volt, d.c shunt motor takes 5A at rated voltage on no-load. Armature and field resistances are 0.8Ω and 300Ω respectively. Calculate the efficiency of the motor for a load current of 50A. **10marks**

18. A DC motor, when connected to a 100V source and to no load runs at 1200rpm. Its stator resistance is 2Ω . What should be the torque and current if it is fed from a 220V supply and its speed is 1500rpm? Assume that the field is constant. **10marks**

19. A 3-phase, 3000/380V, 60Hz transformer has its high-voltage winding connected in delta and low-voltage winding connected in star. If a load consisting of three coils, each having a resistance of 6Ω and an inductance of 21.23mH , are joined in delta across the low-voltage side,

calculate:

(a) The kW delivered to the load

(b) Currents in the low and high-voltage windings and current draw by the transformer from line. Neglect losses and no-load current of the transformer .

10marks

20. The 40kVA is operating at 0.6pf lagging, 50kVA operating at 0.9pf and 45kW operating at unity pf, are the three loads connected to a 400V three-phase supply. If these three loads are connected as subcircuits to a distribution board, calculate the line current in the sub main cable supplying the board.

10marks

SECTION III. ANSWER ANY ONE (1) QUESTION.

21. A d.c shunt motor-generator set running at 15rev/s supplies a current of 15A to an external load connected to the generation terminals. At this load, the motor connected to a 120V supply takes a current of 14A. Armature resistance of motor and generator are 0.6 and 0.4 respectively, field current of motor and generator are 4A and 2A respectively, constant losses of motor and generator are 116W and 48W respectively.

Calculate:

15marks

(a) The shunt field resistance of motor and mechanical power delivered to the motor shaft

(b) Efficiency of motor and motor output torque

(c) Mechanical input to generator and efficiency of the motor-generator set

22. A coil having an inductance of 0.04H and a resistance of 8Ω is arranged in parallel with another coil having an inductance of 0.1H and resistance of 2Ω .

a. Calculate the current through the combination and the power absorbed when a voltage of 120V at 50Hz is applied.

b. Estimate the resistance of a single coil which will take the same current at same power factor.

15marks

23. A 120-kVA, 6,000/400V, Y/Y 3-phase, 50-Hz transformer has an iron loss of 1,600 W. The maximum efficiency occurs at $3/4$ full load. Find the efficiencies of the transformer at:

a) Full-load and 0.8 power factor;

b) Half-load and unity power factor and

c) The maximum efficiency.

15marks