

**ETL - Electricity, Pneumatic and
Hydraulic Automation**

T033

Wednesday, 06/11/2013

8:30 – 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY



P.O.BOX 2707 Kigali, Rwanda Tel: (+250) 255113365

**ADVANCED LEVEL NATIONAL EXAMINATIONS, 2013;
TECHNICAL AND PROFESSIONAL TRADES**

**EXAM TITLE: Electricity, Pneumatic and
Hydraulic Automation**

OPTION: Electronics and Telecommunication (ETL)

DURATION: 3hours

INSTRUCTIONS:

The paper is contains Three (3) Sections:

Section I: Fourteen (14) 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. Attempt all the 14 questions 55marks

01. A television station operates at a frequency of 200 MHz. What inductance is needed with a capacitance of 1.5 pF to form a circuit resonant to this frequency? **3marks**
02. A doorbell transformer has an 800 turn primary and a 20 turn secondary. When the primary is connected to a 60 Hz, 120 volt line, what is the secondary voltage? If a current of 0.5 amp is present in the secondary when the doorbell is operated, what is the current drawn in the primary circuit? **4marks**
03. The 6-pole, wound- rotor induction motor is excited by a 3-phase, 60Hz. Calculate the frequency of the rotor current under the following conditions:
- a) At standstill
 - b) Motor turning at 500 rpm in the same direction as the revolving field
 - c) Motor turning at 500 rpm in the opposite direction as the revolving field. **4marks**
04. Explain the difference between alternating current (AC) and direct current (DC). **4marks**
05. What are the advantages of using an AC motor rather than a DC motor? **4marks**
06. What do we mean by the following terms in electrostatics? **4marks**
- a) Inductance c) Solenoid
 - b) Reactance d) Permeability
07. A resistor, an inductor and a capacitor are connected in series across an ac voltage source. A voltmeter measures 12.0 V, 15.5 V and 10.5 V respectively, when placed across each element separately. What is the magnitude of the voltage of the source? **3marks**
08. The ac supply in some countries is 110 V r.m.s at 50 Hz (sinusoidal).
- a) What is the peak value of voltage?
 - b) What is the peak-to-peak value of voltage?
 - c) How long does one cycle of this ac supply last?
 - d) A 100 W lamp is designed for use with 110 V ac, what is the resistance of its filament? **4marks**
09. What is the procedure to paralleling DC generators? **5marks**

10. A series resonant band stop filter consists of series resistance of $2k\Omega$ across which is connected a series-resonant circuit consisting of a coil of resistance 10Ω and inductance $350mH$ and a capacitor of capacitance $181 pF$ if the applied signal voltage is $10\angle 0^\circ$ of variable frequency. Calculate:
- Resonant frequency f_0
 - Half-power bandwidth B_{hp}
 - Edge frequencies f_1 and f_2
 - Output voltage at frequencies f_0 and f_1
- 5marks
11. Draw the basic hydraulic diagram circuit where we can find the following components:
- oil tank
 - hydraulic pump one volumetric flow direction
 - a double acting cylinder
 - a 4/3 directional valve operated electrically middle closed
 - working lines.
- 5marks
12. A one liter sample of air at room on STP is compressed to a volume of $3.3cm^3$ at a pressure of $1000atm$. Find its temperature after compression. 3marks
13. A pipe of $105.6mm$ of diameter carries fuel of 1200 liters per minute of volumetric flow and density equals to $0.8Kg/dm^3$ and viscosity of 2 stokes. Determine the type of the flow in the pipe. 5marks
14. What is the function of the following elements? 2marks
- Proportional control valves.
 - Servo directional control valves.

Section II: Choose and answer any (3) questions. 30marks

15. An empty lift has a weight of $7200 N$ and is powered by an electric motor. The lift takes a person up $25 m$ in 40 seconds. The person weighs $800 N$.
- Calculate the total weight raised by the lift's motor.
 - Calculate the work done by the lift's motor.
 - Calculate the power output of the motor.
 - Calculate the energy gained by the person in taking the lift.
 - If instead the person climbed the stairs to the same height in 2 minutes, calculate the power generated by the person in climbing the stairs.
 - Give three disadvantages of using a lift.
- 10marks
16. A shunt generator has a full load current of $196A$ at $220V$. The losses are $720W$ and the shunt field coil resistance is 55Ω . It has a full load efficiency of 0.88 , find the armature resistance and the load current corresponding to maximum efficiency. 10marks
17. Compare the magnetic circuit and the electric circuit 10marks

18. A cubic water tank has a surface area of 6m^2 and is filled to 90% capacity six times daily. The water is heated from 20°C to 65°C . The losses per squaremeter of tank surface per 1°C temperature difference are 6.3W . Find the loading in kW and the efficiencies of the tank. Assume specific heat of water equals to $4200\text{ J/Kg}/^\circ\text{C}$ and one kWh = 3.6MJ

10marks

19. Why the induction motor is widely used by the industries?

10marks

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

20. Indicate the applications of dielectric heating.

15marks

21. A 400V , 3-phase, 50Hz , 4 pole, star connected induction motor takes at line current of 10A with 0.86 p.f lagging. Its total stator losses are 5% of the input. Rotor copper losses are 45 of the input to the rotor, and mechanical losses are 35 of the input of the rotor. Calculate:

- a. Slip and rotor speed
- b. Torque developed in the rotor
- c. Shaft torque

15marks

22. An ac voltage = $100\text{V} \cos(2500 t)$ is applied to a series combination of a resistor (300ohms), capacitor ($8\mu\text{f}$), and an inductor (0.02H).

- a. What is the resonant frequency of this circuit?
- b. What is the rms current?

The $8\mu\text{f}$ capacitor is now replaced by a $4\mu\text{f}$ and the 0.02H inductor is replaced by a 0.2H inductor.

- c. What is the rms current in this case?
- d. Draw a phasor diagram of the voltages across each element.
- e. Is this circuit mainly capacitive, or inductive?

15marks