Final Written Examination

5/1/2015

Time all: 3 Hrs

Answer the following questions

Question One: Choose the best answer: ***(YOU CAN SELECT MORE THAN ONE ANSWER)*** **[10 Marks]**

1) ***The LIM (line isolation monitor)***
   - ***a)*** Measures leakage current flowing from the electrical equipment to the patient
   - ***b)*** Sounds an alarm if the leakage current exceeds 50 mA
   - ***c)*** Measures the impedance between AC wiring and ground
   - ***d)*** Cuts off power to the circuit if a faulty piece of equipment is connected
2) ***Operating rooms use an isolated power supply because:***
   - ***a)*** Grounding cannot occur
   - ***b)*** Contact with both wires of the isolation transformer would cause no shock
   - ***c)*** Leakage current is zero
   - ***d)*** It affords protection against high amperage electrocution
3) ***Low voltage = Low hazard***
   - ***a)*** True
   - ***b)*** False
4) ***If a friend receives a severe electric shock from an electrical appliance in your home, what should your first response be?***
   - ***a)*** Take the appliance and heave it aside so that you can tend to your friend.
   - ***b)*** Run to the circuit breaker and turn off the main switch.
   - ***c)*** Use a wooden broomstick to push the appliance away safely.
5) ***Which of the following situations is NOT a fault condition***
   - ***a)*** external voltage on the applied part
   - ***b)*** ingress of gas or fluid
   - ***c)*** mains polarity reversed
   - ***d)*** patient accidentally touching earth

Question *Two:* **[16 Marks]**

A) Complete:

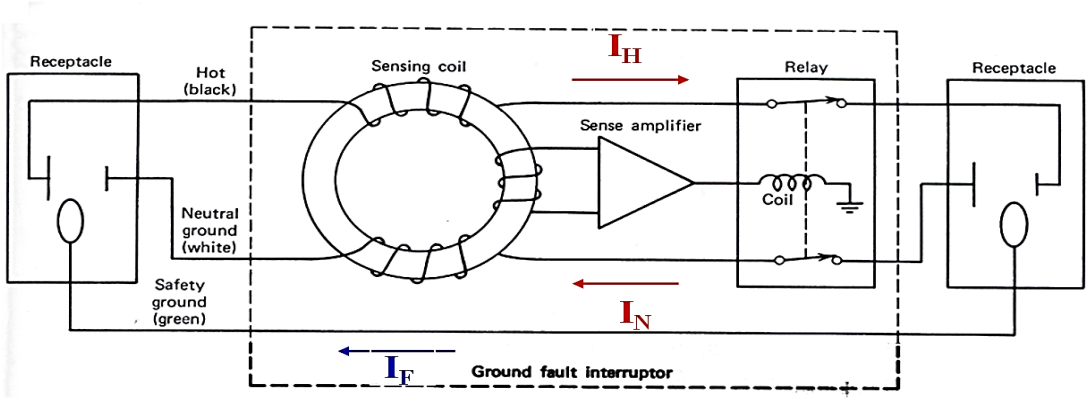
1) **Macroshock** is a large value electrical current (mA) that passes arm to arm and eventually through the heart. It may be lethal. Accepted values are **0.5 mA** sensation (b) **6mA-100mA** -can't let go. **20 mA**. Respiratory failure/fibrillation of the heart- and **10A** and above, burns.
2) There are two major ways to protect patients from shocks **Completely isolate and insulate patient from all sources of electric current** &**Keep all conductive surfaces within reach of the patient at the same voltage.**
3) Electrical safely in medical institutions involves the limitation of **electrical hazard**, such as **shocks, fires , explosions** &**damage for equipment**.

4) Leakage current **is The currents that flow from or between conductors that are insulated from earth** OR **the low value electrical current that leaks from energized electrical portions of an instrument to metal chassis**
The amount of current that flows depends on_
the voltage on the conductor., **the capacitive reactance between two conductor or conductor and earth**.& **the resistance between the conductor and earth.**

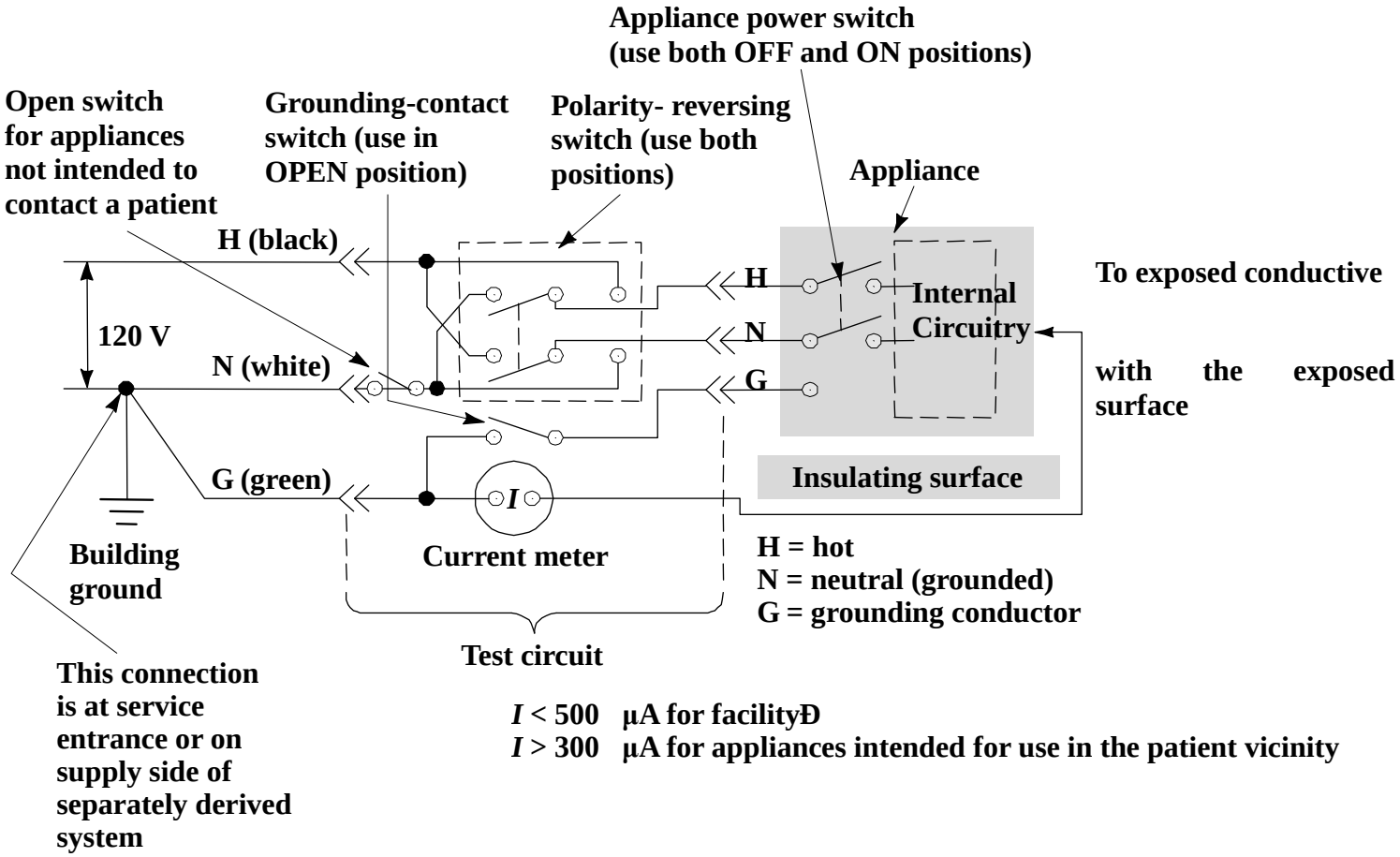
5) The Ground isolated input (ECG) preamplifier has an advantages **of isolate the patient from ground other portion of the equipment ,isolation impedance over 10 M ohm between input terminals and ground** & Disadvantages of **very high cost**.

A) <u>Draw:</u> mention everything in the drawing

1. Ground fault interrupter circuit.



2. Test for chassis leakage current.



$I < 500$ µA for facilityÐ
$I > 300$ µA for appliances intended for use in the patient vicinity

Question Three: **[12 Marks]**

1. How can leakage current are reduced by good: a) Instrument design. b) Clinical conditions.

Leakage current reduction via instrument design:
Through proper layout and insulation to minimize the capacitance between all hot conductors and the chassis

Leakage current reduction via clinical conditions (power distribution):

- Equipotential grounding system.
- Isolated power-distribution system (line isolation transformer with line isolation monitor).
- Ground-fault circuit interrupters (GFCI)

2. What is meant by susceptibility parameters? (mention three of them) And what is the purpose of the earth wire connection in 3-point plugs?

Parameters that changes the physiological effect of the current on patients like:
1) Frequency.
2) Duration.
3) Weight.
4) Points of entry.

The purpose of the earth wire is to make a path for leakage current and fault current.

3. What happens if you personally complete a circuit between the following leads:

a) Hot – Hot
b) Hot – Neutral
c) Hot – Ground
d) Neutral – Ground

From the power company the electricity is distributed as Hot, Neutral and ground wires.

Circuit completed personally	**Effect**
1) Hot – Hot	No effect
2) Hot – Neutral	**Shock hazard**
3) Hot – Ground	Shock hazard
4) Neutral - Ground	No effect

4. Explain with the aid of drawing, what is meant by **"equipotential grounding system"** and why it is used? Where it could be found?

Consist of separate connection from each equipment chassis to a common ground terminal

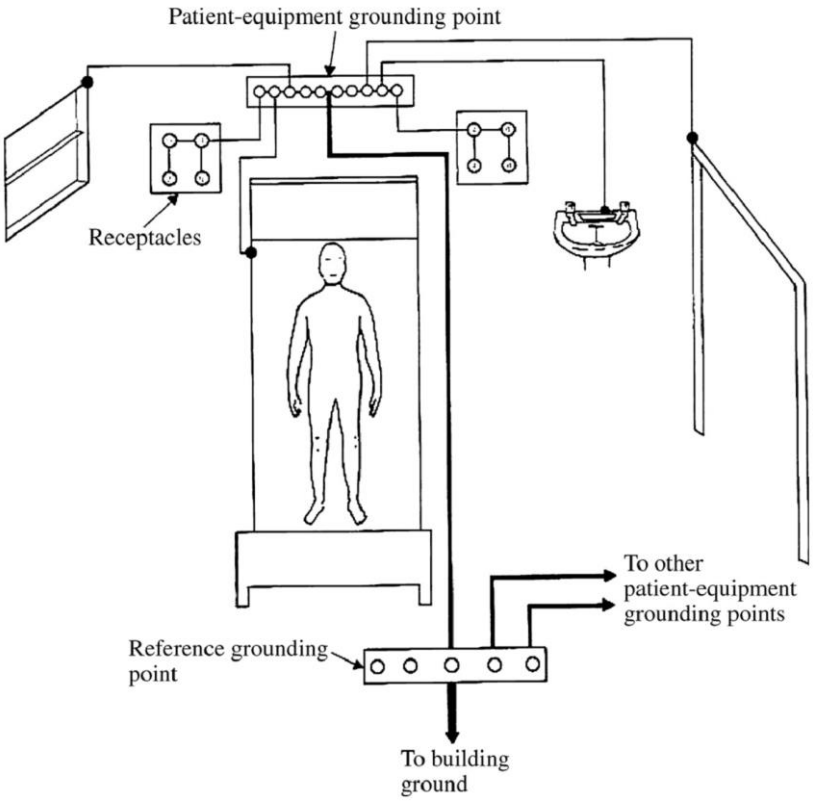
Is achieved by adding another grounding wire from each chassis to a central point that is parallel with a third wire in the power cord

These ground wires have nearly the same length

Each metal chassis is at or near the same potential with respect to each other

Places which the system is used:

1- OR 2- ICU 3- CCU



5. List the items for protection the patient through **Equipment Design**

1. Reliable grounding for equipment

   Strain-relief devices for cords, where cord enters the equipment and between the cord and plug

2. Reduction of leakage current

   Through proper layout and insulation to minimize the capacitance between all hot conductors and the chassis

3. Double insulated equipment

   prevent the contact of the patient with the chassis or any other conducting surface (outer case being insulating material, plastic knobs, etc.)

4. Operation at low voltage

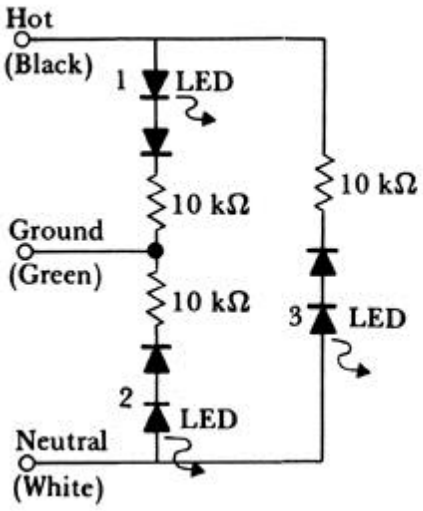
   Solid state devices operating at <10V are far less likely to cause macroshock

5. Electrical isolation

   Electrical isolation in Equipment , circuit designs & Heart connection

Question Four: **[9 Marks]**

1. Design with drawing a complete power and grounding systems for **ICU** that consists of many instruments such as (ECG, EEG, Defibrillator & Saline-filled catheter)
2. Design a tester for an electric receptacle that will indicate as many states as possible, including those not detected by the common three-LED receptacle testers



Wiring Codes (* ≡ LED on)

	1	2	3
1. Hot open (or all hot!)	O	O	O
2. Neutral open	*	O	O
3. No possible wiring	O	*	O
4. Ground open	O	O	*
5. Hot/ground reversed	*	*	O
6. Correct (or ground/neutral reversed)	*	O	*
7. Hot/neutral reversed	O	*	*
8. Hot open and neutral/hot	*	*	*

3. Describe with drawing the ground isolated input (ECG) preamplifier

- **Ground isolated input (ECG) preamplifier**

➢ The isolated patient circuit are achieved by providing an isolation transformer in the signal path in the AC power circuit

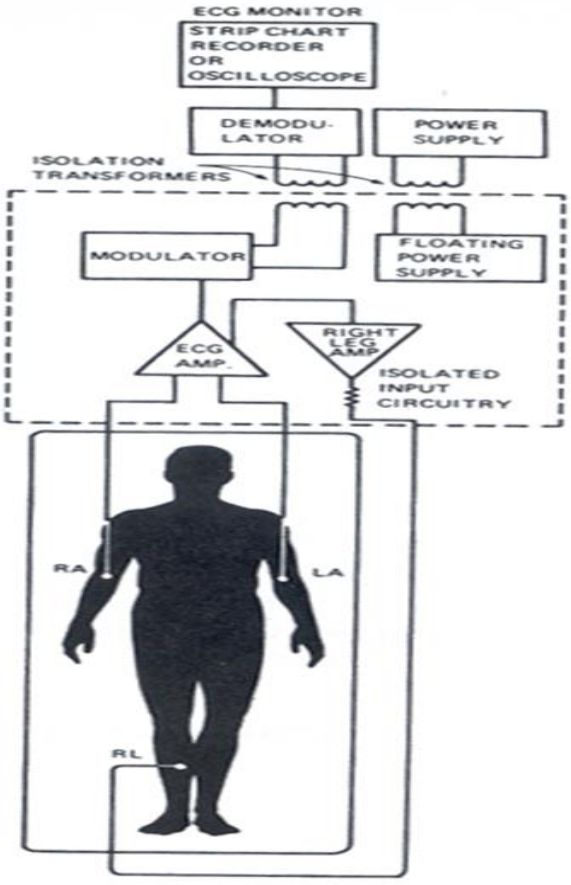
➢ **Advantages :**

1- isolate the patient from ground and other portion of the equipment

2- isolation impedance over 10 M ohm between input terminals and ground

➢ **Disadvantages:**

1- very high cost



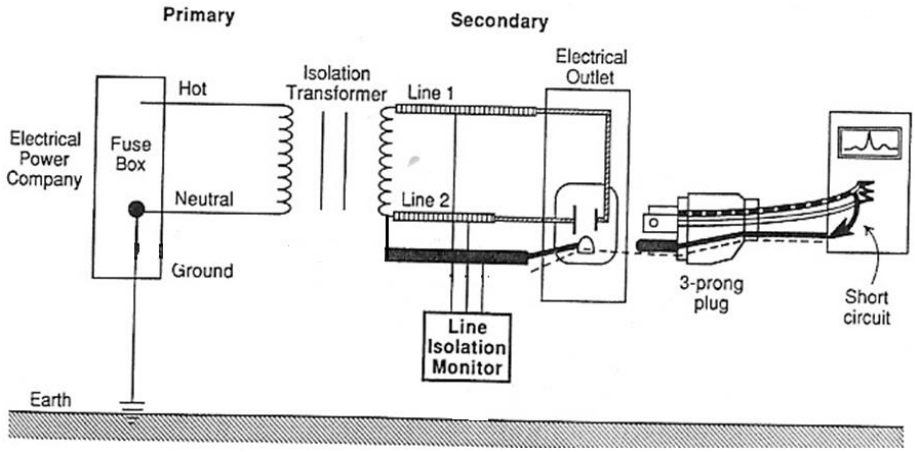
Question Five: **[13 Marks]**

1. In the figure below explain what will be happened,

a) If there is a short circuit between line 1 & line 2. Fuse blown

b) If there is a short circuit between line 2 & device chassis.no thing

c) If there is a short circuit between line 1 & device chassis. Fuse blown



2.

a) Describe the situation in Fig.1with all hazard and reasons for it

The situation is micro shock

Hazards : 1. Short circuit from vacuum cleaner will pass return current to the patient and micro shock occur

2. Different ground will appear voltage on patient and pass current through patient

Reasons: from vacuum cleaner and from the isolated grounding for two instrument

b) Draw the new suitable situation with safe connection to avoid all hazards.

-Not connect any clean device in the same receptacles of patient equipment

-Connect all patient equipment to reference ground in the room and then to central ground point

Draw this item