UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FIRST SEMESTER EXAMINATIONS, NOV. / DEC. 2018

COURSE NO: GL 233

COURSE NAME: BASIC ELECTRICITY

CLASS: GD II

TIME: 3 HOURS

Name: ____Index Number: _______________

Instructions: Attempt **ALL** questions in **Section A** and **any Two** questions from **Section B.**

SECTION A

This section comprises of 60 multiple-choice questions. Attempt all questions in this section. All questions carry equal marks. Provide your answers on the answer sheets by writing the alphabet corresponding to the correct answer in each question.

1. The algebraic sum of the current entering a node at any instant is equal to
   a. the algebraic sum of the current leaving the node
   b. sum of the current any point
   c. zero
   d. sum of current flowing into the node

2. A battery of emf 12 V and internal resistance 1.5 Ω is required to give a current of 0.60 A when connected to an external load of resistance, R. calculate the value of R.
   a. 4.8 Ω
   b. 18.5 Ω
   c. 20.0 Ω
   d. 21.5 Ω

3. A 6.00-V battery is connected to a parallel combination of two resistors, whose values are 8.0 Ω and 12.0 Ω. What is the total power (in watts) dissipated?
   a. 0.30
   b. 3.00
   c. 4.50
   d. 7.50

4. Thevenin's theorem converts a circuit to an equivalent form consisting of
   a. a current source in series with a resistor
   b. a current source in parallel with a resistor
   c. a voltage source in series with a resistor
   d. a voltage source in parallel with a resisitor

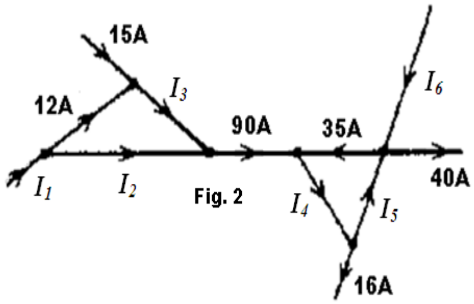
5. Norton's theorem is valid for network containing only
   a. resistance
   b. reactance
   c. linear elements
   d. no linear elements

6. A certain series circuit has 50 Ω, 100 Ω and 120 Ω resistors in series. If the 50 Ω resistor is removed, the current will
   a. become zero
   b. will increase

c. will decrease
d. remain constant

7. When superposition theorem is applied to any circuit, the dependent current source is always
   a. Open circuited
   b. Short circuited
   c. active
   d. none of these
8. An active network has
   a. either current or voltage sources
   b. no current nor voltage sources
   c. only resistors
   d. only inductors and capacitors
9. If one of the resistors in a parallel circuit is remove, what happens to the total resistance?
   a. decreases
   b. increases
   c. exactly doubles
   d. remains constant
10. Three equal resistances when combined in series are 63 Ω. Their equivalent resistance (in ohms) when combined in parallel will be
    a. 3
    b. 7
    c. 21
    d. 189
11. The ohm is a unit of:
    a. electrical charge quantity
    b. electrical conductance
    c. the rate at which charge carriers flow
    d. opposition to electrical current
12. One kilowatt hour of electrical energy is the same as
    a. 3.6×10^5 watts
    b. 3.6×10^5 Joules
    c. 36×10^5 Joules
    d. 3.6×10^6 Joules second
13. Kirchhoff's voltage law is concerned with
    a. IR drop
    b. battery emf
    c. junction voltage
    d. both (a.) and (b.)
14. Superposition theorem is applicable to linear as well as non-linear networks
    a. True
    b. False
15. Suppose you double the voltage in a simple dc circuit, and also double the resistance. The power will become
    a. The same as it was before
    b. Four times as great
    c. Twice as great
    d. Half as great
16. The coulomb is a unit of:
    a. electrical charge quantity
    b. the rate at which charge carriers flow
    c. opposition to electrical current
    d. electrical conductance

Using Fig. 1, determine and fill the table for Questions 17 to 22 with the values of the branch currents labelled I_1 to I_6



Question	Current Designation	Current Value
17.	I_1	
18.	I_2	
19.	I_3	
20.	I_4	
21.	I_1	
22.	I_1	

23. A parallel plate capacitor has a capacitance of C. If the area of the plates is halved and the distance between the plates is doubled, what is the new capacitance?
    a. C/4
    b. C/2
    c. 2C
    d. 4C
24. An electric line of force always starts on
    a. a positive charge and ends on the same charge
    b. a positive charge and ends on a negative charge
    c. a negative charge and ends on a positive charge
    d. a negative charge and ends on another negative charge
25. The force acting between two point charges can be computed using
    a. Ohm's Law
    b. Ampere's Law
    c. Kirchhoff's Law
    d. Coulomb's Law
26. Two charges are separated by a distance d and exert mutual attractive forces of F on each other. If the charges are separated by a distance of d/3, what are the new mutual forces?
    a. F/9
    b. F/3
    c. 3F
    d. 9F
27. A dielectric material such as paper is placed between the plates of a capacitor. What happens to the capacitor?
    a. becomes smaller
    b. becomes larger
    c. becomes infinite
    d. remains unchanged

28. A capacitor C has a charge Q. the actual charges on its plates are

a. Q, 0
b. Q/2, Q/2
c. Q, Q
d. Q, -Q

29. Doubling the voltage across a given capacitor causes the energy stored in that capacitor to

a. reduce to one half
b. double
c. quadruple
d. reduce to one fourth

30. The capacitance of a parallel plate capacitor is

a. proportional to the plate area
b. inversely proportional to the plate area
c. proportional to the charge stored
d. proportional to the plate separation

31. A parallel plate capacitor has plates each of area $0.01m^2$ and with separation 0.25 mm. What is its capacitance in free space?

a. 40 nF
b. 0.35 nF
c. 4.4 μF
d. 88 pF

32. Let Q denote charge, V denote potential difference and E denote stored energy. Of these quantities, capacitors in series must have the same:

a. Q only
b. V only
c. E only
d. Q and E only

33. A charge of 1.5 μC is carried on 2 parallel rectangular plates each measuring 60 mm by 80 mm. If the plates are spaced 10 mm apart and the voltage between them is 0.5 kV, then the electric field strength is

a. 312.5 $\mu C/m^2$
b. 50 kV
c. 4.5 V/m
d. 50 000 V/m

34. How many plates has a parallel plate capacitor having a capacitance of 5 nF, if each plate is 40 mm by 40 mm, and each dielectric is 0.102 mm thick with a relative permittivity of 6?

a. 7
b. 8
c. 10
d. 12

35. A 3300 pF capacitor is required to store 0.5 mJ of energy. The potential difference to which the capacitor must be charged is

a. 220 V
b. 0.300 kV
c. 0.23 kV
d. 550 V

36. Two capacitors having capacitances of 10 μF and 15 μF are connected in series. The value of a third capacitor when connected in series with the other two giving a resultant capacitance of 3 μF will be

a. 6 μF
b. 9 μF
c. 28 μF
d. 36 μF

Use Figure 1 to answer questions 37 to 40.

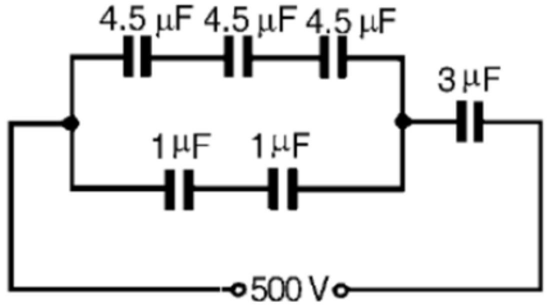


Figure 1 for questions 37 to 40

37. Find the equivalent circuit capacitance.
    a. 1.2 μF
    b. 1.5 μF
    c. 3 μF
    d. 47 μF
38. What is the voltage across the 3 μF capacitor?
    a. 100 V
    b. 200 V
    c. 300 V
    d. 500 V
39. Determine the charge on a 1 μF capacitor.
    a. 600 μC
    b. 450 μC
    c. 150 μC
    d. 100 μC
40. Find the voltage across a 4.5 μF capacitor
    a. 100 V
    b. 200 V
    c. 300 V
    d. 500 V
41. A soft iron bar is introduced inside a current carrying solenoid. The magnetic field inside the solenoid
    a. will become zero
    b. will decrease
    c. will increase
    d. will remain unaffected
42. The direction of the force on a current-carrying wire placed in a magnetic field depends on
    a. the direction of the current
    b. the direction of the field
    c. the direction of current as well as field
    d. none of these
43. Electromagnetic induction is the
    a. charging of a body with a positive charge
    b. production of current by relative motion between a magnet and a coil
    c. rotation of the coil of an electric motor
    d. generation of magnetic field due to a current carrying solenoid

44. In case of two circuits, the magnetic flux linked with one due to a unit current flowing in the other is called

a. induced current
b. induced emf
c. self-inductance of the first circuit
d. mutual inductance of the two circuits

45. A material that can be permanently magnetized is generally said to be

a. magnetic
b. electro magnetic
c. permanently magnetic
d. ferromagnetic

46. Lines of magnetic flux are said to originate

a. in atoms of ferromagnetic materials
b. at a north magnetic pole
c. where the lines converge to a point
d. in charge carriers

47. The magnetic flux around a straight, current-carrying wire

a. gets stronger with increasing distance from the wire
b. is strongest near the wire
c. does not vary in strength with distance from the wire
d. consists of straight lines parallel to the wire

48. If a wire coils has 10 turns and carries 500 mA of current, what is the magnetomotive ampere-turns.

a. 0.02
b. 5.0
c. 50
d. 5000

49. The flux density (T) existing in an area of 400 mm^2 if a uniform magnetic flux of $300\ \mu Wb$ exists at right angles to that area is

a. 0.22
b. 0.75
c. 1.33
d. 1.85

50. The flux density (T) produced in an iron ring of relative permeability 1600 which is uniformly wound with a coil producing a magnetic field strength of 500 A/m is given as

a. 5.21
b. 2.05
c. 1.01
d. 0.45

51. A current-carrying conductor is situated at right-angles in a uniform magnetic field having a density of 0.3 T. The force in newtons per length on the conductor when the current is 200 A is

a. 30
b. 60
c. 100
d. 600

52. A coil of 200 turns is wound uniformly over a wooden ring having a mean circumference of 600 mm and a uniform cross-sectional area of 500 mm^2. If the current through the coil is 4 A, the flux density will be

a. $1675\ \mu T$

b. 1333 T

c. 160 T

d. $0.7\ \mu T$

53. The difference between alternating (ac) and direct current (dc) is

a. ac changes value but dc does not

b. ac changes direction and dc does not

c. both ac and dc change value and direction

d. both (a) and (b)

54. The number of cycles completed in one second is called

a. frequency

b. period

c. peak voltage

d. amplitude

55. When a sine wave has a frequency of 80 Hz, in 5 seconds it goes through ________ cycles.

a. 1/16

b. 16

c. 80

d. 400

56. If the peak value of a sine wave is 10 V, the peak-to-peak value is _________ volts

a. 5

b. 10

c. 20

d. 100

57. What is the instantaneous peak voltage at 250^o on a 6 V peak sine wave?

a. -26.13 V

b. -5.64 V

c. +5.64

d. +26.13

58. The rms value of the ac voltage $v(t) = 314\ \sin 200t$ is

a. 141.42 V

b. 157.23 V

c. 200 V

d. 314 V

59. The phase angle between the two waveforms in the given circuit equals ________

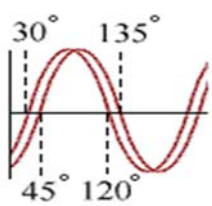


Figure 2 for question 59

a. 15^o

b. 45^o

c. 75^o

d. 255^o

60. If the rms current through a 10 kΩ resistor is 5 mA, the rms voltage drop across the resistor _________ volts

a. 5

b. 7.07

c. 70.7

d. 50

SECTION B

Question 1

(a) Differentiate between

i. active and passive element

ii. conductance and conductivity ***(4 marks)***

(b) Using Thevenin's theorem, determine the current in the 8-Ω resistor in Figure 3

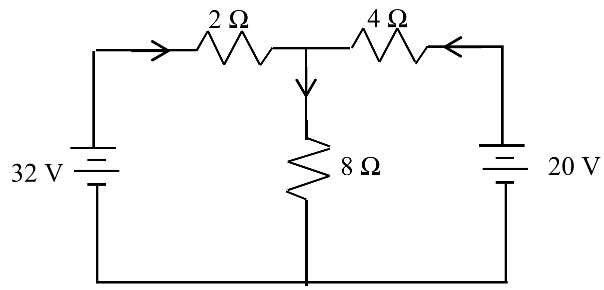


Figure 3 for question **1(b)** ***(12 marks)***

(c) Use the principle of superposition to find the current I_{10} in the network shown in Figure 4.

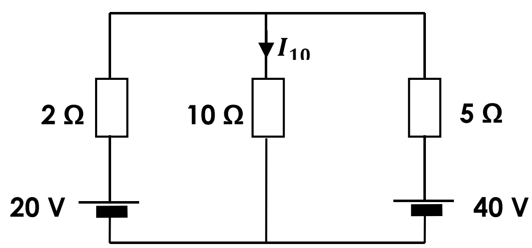


Figure 4 for question **1(c)**

(14 marks)

Question 2

(a) Define the following terms as applied to electrostatics

i. Electric field

ii. Electric flux

iii. Electric field strength (***6 marks)***

(b) An alternating current of frequency 50 Hz has a maximum value of 100 A.

i. Write down an expression for the instantaneous current i

ii. Determine the *period* and the *rms* value, I_{rms}

iii. Find the value of the current $\frac{1}{600}$ *second* after the current is zero. (***9 marks)***

(c) A parallel-plate capacitor has plate area of 100 cm^2 and a separation of 2.5 mm. A potential difference of 1.0 kV is applied across the plates with only air between the plates. The battery is then disconnected, and a piece of glass ($\varepsilon_r = 8.0$) is inserted to completely fill the space between the plates.

(α) What is the

i. Capacitance
ii. Charge on the plates and
iii. Electric field intensity **before** the dielectric is inserted?

(β) Determine the
i. Capacitance
ii. Charge on the plates
iii. Potential difference across the plates
iv. Electric flux density and
v. Maximum energy stored by the capacitor **after** the dielectric is inserted.

(*15 marks*)

Question 3

(a) Define the following terms and state their respective units of measurements:

i. Magnetomotive force
ii. Magnetic flux
iii. Reluctance

(6 marks)

(b) Figure 5 shows an iron ring of mean circumference *40 cm* and cross-sectional area *25 mm*^{2} with a relative permeability of *800*. It has a coil of *100* turns wound around it and a 1mm air gap cut radially through it. Calculate the current in the coil to maintain a flux density of 0.42 T in the iron ring and in the air gap. ***(12 marks)***

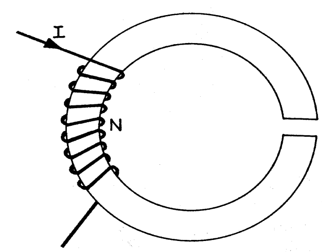


Figure 5 for question **3 (b)**

(c) A rectangular shaped core is made of mild-steel plate 20 $mm \times 30\ mm$ cross-section. The mean length of the magnetic path is 45 cm. The coil has 500 turns and current 0.8 A. If the relative permeability of mild steel is 950,

Calculate:

i. magnetising force
ii. ampere-turns required
iii. flux density
iv. reluctance
v. flux of magnetic circuit

Examiners: S. Ofori/ Dr J. C. Attachie