UNIVERSITY OF NIGERIA, NSUKKA
DEPARTMENT OF ELECTRICAL ENGINEERING
2016/17 END OF FIRST SEMESTER EXAMINATIONS

EEE 211: BASIC ELECTRICAL ENGINEERING I

TIME ALLOWED: 3 Hours

DO NOT WRITE ANYTHING ON THIS QUESTION PAPER
ANSWER ANY TWO QUESTIONS FROM EACH SECTION INTO A SEPARATE ANSWER BOOKLET

SECTION A: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'A'

A1. A charge Q is placed at each of two opposite corners of a square. A charge q is placed at each of the other two corners. If the resultant electrical force on Q is zero, how are Q and q related?

A2. What is the electric field E in magnitude and direction at the centre of Fig A2. Assume that $q = 1.0 \times 10^{-8}C$ and $a = 5cm$.

A3. A magnetic circuit is made of mild steel arranged as in Figure A3. The centre limb is wound with 500 turns and has a cross-sectional area of 800mm². Each of the outer limbs has a cross-sectional area of 500mm². The air-gap has a length of 1mm. Calculate the current required to set up a flux of 1.3mwb in the centre limb, assuming no magnetic leakage and fringing. The mean lengths of the various magnetic paths are shown on the diagram and the relationship between flux density and magnetic field strength mild steel is shown in Table 3.

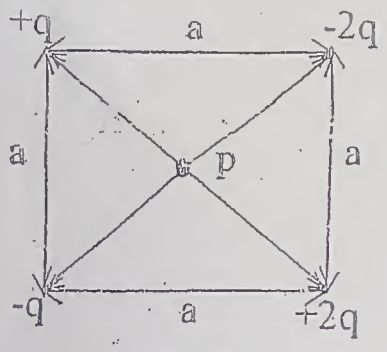


Figure A2

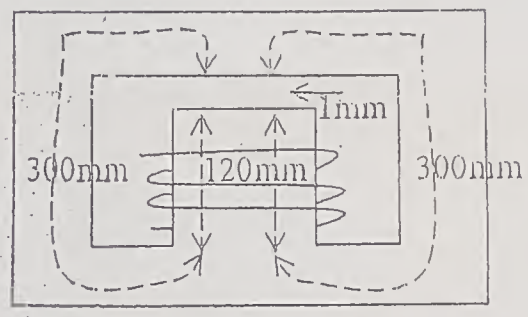


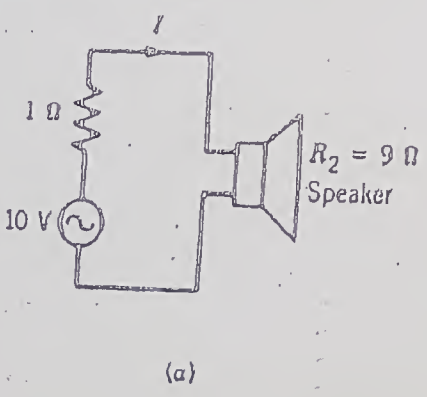
Figure A3

Table 3

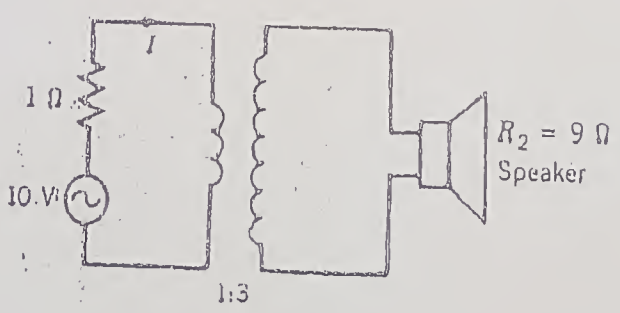
Flux density wb/m² (T)	1.2	1.3	1.4	1.5	1.625
Magnetic field strength A/m	480	850	1460	2000	3800

SECTION B: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'B'

B1. A speaker of 9Ω resistance is connected to a supply of 10V with internal resistive impedance of 1Ω as shown in Figure B1(a). (a) Determine the power absorbed by the speaker, (b) To maximize the power transfer to the speaker, an ideal transformer of 1:3 turns ratio is used between the source and the speaker as shown in Figure 1(b). Determine the power taken by the speaker in this case.



(a)



(b)

Figure B1

B2. A 100kVA, 2400/240-V, 50Hz single-phase transformer has a no-load current of 0.64A and a core loss of 700W when its high voltage side is energized at rated voltage and frequency.

Calculate: (a) the values of the two components of the no-load current and (b) the no-load power factor of the transformer.

B3. (a) Draw the per-phase actual equivalent circuit of a transformer and label all the components.
(b) An ideal transformer with $N_1 = 100$ turns and $N_2 = 200$ turns has a mutual coupling flux given by. $\varphi_m = 0.63 + 0.05(t^2 - t)Wb$. Determine the input and output terminal voltages V_1 and V_2 at $t = 5$secs.

SECTION C: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'C'

C1. Three emfs $e_a = 100\sin\omega t$, $e_b = 150\cos\omega t$ and $e_c = 200\sin\left(\omega t - \frac{\pi}{4}\right)$ volts are induced in three coils connected in series so as to give the phasor sum of the three emfs, compute: (a) the resultant emf, (b) the phase difference relative to e_a, (c) the rms value and (d) the form factor.

C2. A resistance $R = 10\Omega$ and a inductance $L = 60mH$ are connected in series and the overall set connected across a 150V, 50Hz supply, calculate: (a) the reactance of the inductor (b) the impedance of the circuit (c) the current in the circuit (d) the phase angle between the current and the applied voltage (e) the power factor (f) the apparent power (g) the active power (h) the reactive power.

C3. A series R-L-C circuit has $R = 4\Omega$ and $C = 20.3\mu F$. The entire series circuit is then connected across a 100V 50Hz supply. Determine: (a) the inductance to give resonance, (b) the voltage across the inductor, (c) the voltage across the capacitor, (d) the quality factor of the circuit, (e) the dynamic impedance of the circuit and (f) What is the significance of the result(s) obtained in 'b' and 'c' above?

SECTION D: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'D'

D1: (a) Using Thevenin's theorem, find the current in 6 Ω resistor in the Figure D1(a).
(b): A silicon n-p-n transistor with $\alpha = 0.99$ and $I_{CBO} = 10^{-11}$ is connected as shown in Figure D1(b). Predict i_C, i_E, and V_{CE}.

D2: (a) Obtain the current i_1 using KVL in the Figure D2(a). (b) A full-wave bridge rectifier circuit has a transformer with input voltage of 230 V and frequency of 50 Hz. Assuming the diodes to be ideal, determine the quantities (a) d.c. output voltage (b) PIV of a diode and (c) output frequency. Given that R_L is 200 Ω and transformer turn ratio of N_2/N_1 is 1/4.

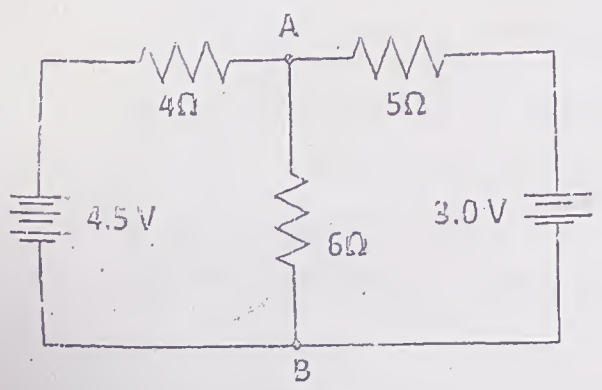


Figure D1(a)

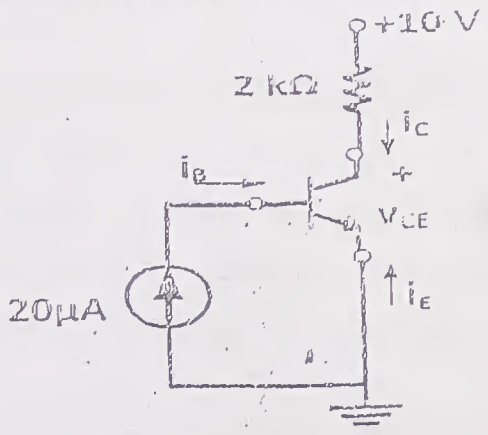


Figure D1(b)

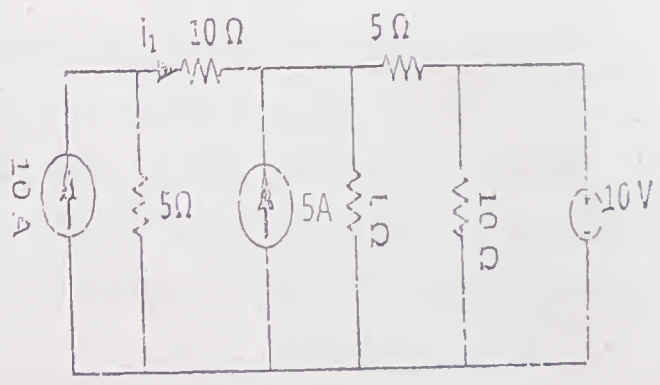


Figure D2(a)

D3 (a): A coil having resistance of 10 Ω and inductance of 1.0 H is switched on to a direct voltage of 100 V_{dc}. Calculate the rate of change of the current (a) at the instant of closing the switch and (b) when $\tau = L/R$ (c) Also, find the steady state value of the current.
(b): The current voltage characteristic of a P-N junction diode is given by the relation:
$I = I_0.(e^{qV/\eta.k.T} - 1)$. The diode current is 0.5 mA at V = 340 mV and 15 mA at V = 440 mV. Determine the value of η. Assume kT/q = 25 mV.

ES Obe, LU Anih, DBN Nnadi & SE Oti, Nsukka, March 20, 2017

SECTION C: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'C'

C1. The current through a series RLC circuit is $10\cos(2000t-240^0)$ A and the voltage across the set is $280.4\cos(2000t-60^0)$ V. If C = 40μF, calculate the values of: (a) the resistor R, (b) the inductor L. (c) which phenomenon is at play?

C2. An ac circuit is supplied from 50Hz mains, the voltage and current have maximum values of 500V and 12A respectively. At a time t=0, the instantaneous values of the voltage and current are 400V and 5A both increasing positively. Assuming sinusoidal variation: (a) Derive relations for the instantaneous values of voltage and current, (b) Calculate the instantaneous values of voltage and current at t=4ms and (c) Determine the phase difference between the voltage and current.

C3. Use the circuit of Fig. C3 to calculate the: (a) value of 'C' to give resonance if the 12Ω resistance is neglected, (b) Q-factor, (c) dynamic impedance, (d) potential difference across the parallel branch and (e) difference between the inductive and capacitive currents at resonance.

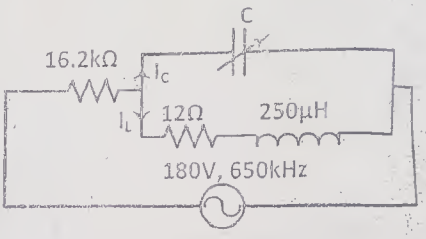


Fig. C3

SECTION D: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'D'

D1. Using nodal analysis approach, find the total power consumed in the circuit of Fig. D1.

D2. Calculate the current in each branch of the circuit of Fig. D2 using Maxwell's mesh analysis.

D3. In Fig. D3, C and D represent two terminals of an active network. Using the Thevenin's theorem, calculate the current through R_3.

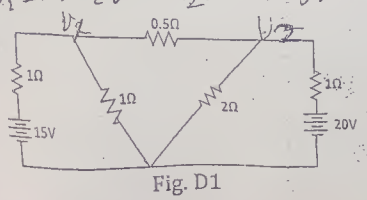


Fig. D1

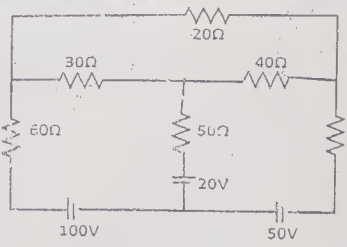


Fig. D2

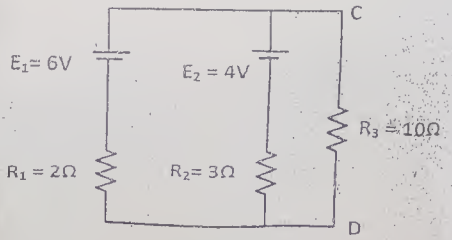


Fig. D3

SECTION C

Q.6. For the circuit of Fig 6.1, determine the Thevenin equivalent circuit as seen from terminal AB. Hence, derive Norton's equivalent circuit as seen from AB.

Q.7 Use Nodal Analysis to determine the voltages v_1 and v_2 in Fig 7.1. Hence determine the current in the 1.5 Ω resistor

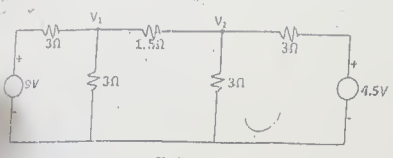


Fig. 7.1

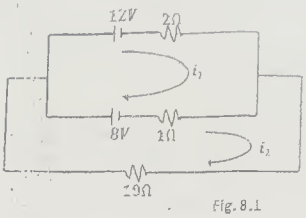


Fig. 8.1

Q. 8. For the circuit of Fig. 8.1, determine the mesh current i_1 and i_2. What is the current through the battery?

SECTION D

Q.9. A circuit of the type shown in Figure Q.9 in which $R = 12\Omega$, $L = 100$mH and $C = 50\mu$F, is supplied by a 200V r.m.s, 318.3Hz source. Determine:

(a) the value of the currents, I_R, I_L and I_C in each branch of the circuit,
(b) the total current drawn from the supply and its phase angle
(c) Draw a phasor diagram representing all the currents calculated in (a) and (b) above.

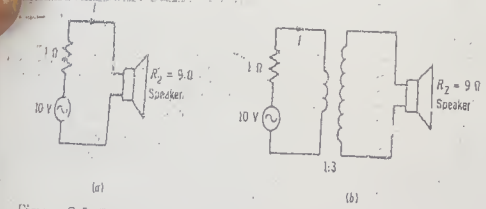


Figure Q.9: Pertaining to Question Q.9

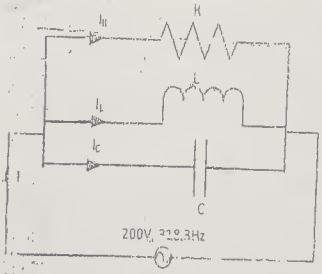


Figure Q.12 : Pertaining to Question Q.12

Q.10 A 500V, 50Hz single-phase motor draws a full load current of 40A at a power factor of 0.8 lagging.
(a) Calculate the real, reactive and apparent power consumed by the motor.
If a capacitor of 80μF is connected in parallel with the motor, determine:
(b) the current drawn by the combination of motor and the capacitor.
(c) What will be the new power factor of the combination?

Q.11. Two coils are wound on a common magnetic circuit and have inductances of 1 H and 0.64 H. If the coupling coefficient is 0.5, determine (i) the mutual inductance between the coils and (ii) the inductance of the circuit if they are connected in (a) series-aiding, (b) series-opposing. If the current in the circuit in cases (a) and (b) above changes at the rate of 100 A/s, determine the induced e.m.f. in each case.

Q.12. A speaker of 9Ω resistance is connected to a supply of 10V with internal resistive impedance of 1Ω as shown in Figure Q.12 (a).
(a) Determine the power absorbed by the speaker.
(b) To maximize the power transfer to the speaker, an ideal transformer of 1:3 turns ratio is used between the source and the speaker as shown in Figure Q.12 (b). Determine the power taken by the speaker in this case.

OBUTE

UNIVERSITY OF NIGERIA NSUKKA
DEPARTMENT OF ELECTRICAL ENGINEERING
2013/2014 1ST SEMESTER EXAMINATION
ANWSER 7 QUESTIONS, AT LEAST ONE FROM EACH SECTION
TIME ALLOWED: 3 HOURS

SECTION A

Q. 1. A dc voltage of 17.2v is applied across a copper conductor which has length of 100km, X sectional area of 1cm² and mobility constant of 0.0032. The free electron concentration in the conductor is 10^{29} electrons/m³. Determine the conductivity of the copper conductor. Also determine the electric field intensity and the electron drift velocity in the conductor

Q. 2. Define the electric field intensity and the electric field potential (at a point P in a medium) due to an isolated charge Q located at a distance r from the point P

In Fig. 2.1, the two composite dielectric materials in the parallel plate conductor have thickness of d_1 and d_2 metres respectively and permittivity of ε_1 and ε_2 respectively. A dc voltage V applied across the plates produce charges of magnitude Q in each plate. The area of each plate is A m².

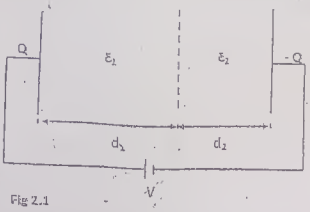


Fig 2.1

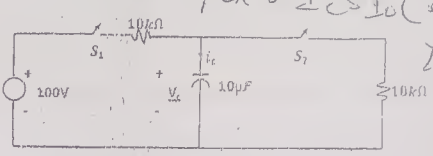


Fig 3.1

Determine the expression for the capacitance of the parallel plate conductor arrangement. If A = 5cm², $\frac{d_1}{\varepsilon_1} = 1.5$ and $\frac{d_2}{\varepsilon_2} = 3.5$, determine thee capacitance of the parallel plate arrangement

Q. 3. In Fig 3.1, switches S_1 and S_2 are initially open and the initial capacitor voltage is zero. At time $t = 0$, S_1 is closed. Determine the time variation of the capacitor current i_c and voltage v_c for $t \geq 0$. Hence determine i_c and v_c at $t = 0.4$ sec and $t = 1.0$ sec.

At $t = 1.0$ sec, S_1 is opened and S_2 simultaneously closed. Determine the value of i_c and v_c at $t = 1.1$ secs

SECTION B

Q.4. An iron ring of relative permeability 1096 has X-section of 3cm² and a mean diameter of 25 cm. An air gap of 4mm has been cut across the section of the ring. The ring is wound with 400 turns of coil through which a current of 2A flows. Determine the flux density in the iron ring. Also determine the inductance presented by the wound ring to the its electric supply input. Permeability of free space is $4\pi \times 10^{-7}$ H/m

Q. 5 In Fig 5.1, switches S_1 and S_2 are initially open and the inductor current i_l is zero. At $t = 0$, S_1 is closed. At $t = 2$ms, S_1 is opened and S_2 simultaneously closed. Determine the time variation of the inductor current i_l for $t \geq 2$ms. What is the instantaneous value of i_l at $t = 3$ms ?

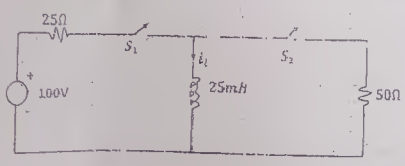


Fig 5.1

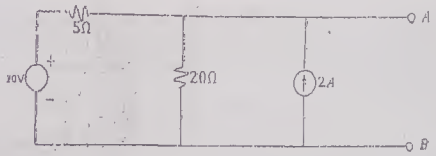


Fig. 6.1

UNIVERSITY OF NIGERIA, NSUKKA
DEPARTMENT OF ELECTRICAL ENGINEERING
2015/16 END OF FIRST SEMESTER EXAMINATIONS

EEE 211: BASIC ELECTRICAL ENGINEERING I

TIME ALLOWED: 3 Hours

SECTION A

DO NOT WRITE ANYTHING ON THIS QUESTION PAPER

ANSWER ANY TWO QUESTIONS FROM EACH SECTION INTO A DIFFERENT ANSWER BOOKLET

SECTION A: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'A'

A1. If an alternating current passing through a resistor immersed in water just brings the temperature to boiling point in 5 min, and a direct current of 4A takes 8 minutes to do the same, find the peak value of the alternating current.

A2. A 40kVA, single phase core type transformer has 400 turns on the primary and 100 turns on the secondary. The primary is connected to a 2000V, 50Hz supply. Determine: (a) the secondary voltage on open circuit, (b) the current flowing through the two windings on full load and (c) the maximum value of the flux in the core.

A3. (a) Sketch and label the equivalent circuits of (i) a dc shunt machine and (ii) a series d.c machine.
(b) A 230V dc shunt motor takes a current of 32A at full load. Find the back emf on full load if the resistances of the armature and shunt field winding are 0.2 ohm and 115 ohms respectively.

SECTION B: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'B'

B1. Fig. B1 shows three charges q_1, q_2 and q_3. What force acts on q_1? Assume that $q_1 = -1.0 \times 10^{-6}$C, $q_2 = +3.0 \times 10^{-6}$C, $q_3 = -2.0 \times 10^{-6}$C, $r_{12} = 15$cm, $r_{13} = 10$cm and $\theta = 30^0$.

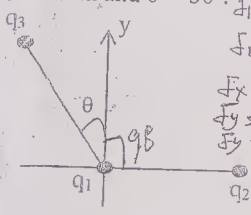


Fig. B1

B2: In a delta connected load of sequence RYB, a 100Ω resistor is connected between the terminals R and Y, a 30μF capacitor is connected between R and B while a 20Ω resistor in ries with 60Ω inductive reactance is connected between Y and B. Calculate: (a) the phase currents, (b) the line currents, (c) total active power consumed by the load, (d) total reactive power consumed by the load and (e) the apparent power. Take the three-phase supply voltage to be 400V at 50Hz.

B3. An iron ring has a mean diameter of 6.4cm and an air gap length of 1mm is cut out from the ring. If the ring has a winding of 200 turns while a current of 1A flows through the winding and the flux density in the iron is 94mWb/m², find the permeability of the iron. Assume that there is no fringing of flux in the air gap.

UNIVERSITY OF NIGERIA, NSUKKA
DEPARTMENT OF ELECTRICAL ENGINEERING
2018/19 END OF FIRST SEMESTER EXAMINATIONS

EEE 211: BASIC ELECTRICAL ENGINEERING I

TIME ALLOWED: 2 Hours 40 Minutes

DO NOT WRITE ANYTHING ON THIS QUESTION PAPER

TIME ALLOWED is 2 ½ HOURS

SOPHISTICATED CALCULATORS AND MOBILE PHONES ARE PROHIBITED IN THE EXAMINATION HALL

(wherever needed, take ε=8.854 × 10^{-12} F/m and $\mu = 4\pi \times 10^{-7}$ H/m)

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SECTION A: ANSWER ANY TWO QUESTIONS FROM THIS SECTION INTO SCRIPT X

Q.A1: Three point charges of values Q_A = **10μC**, Q_B = **5μC** and Q_C = **5μC** are placed at points **A**, **B**, and **C** respectively in a two dimensional plane shown in Figure Q.A1. Determine the electric field intensity at point **D**.

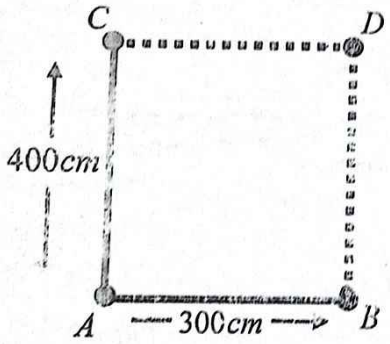

Figure Q. A1

Q.A2: **(a)** Briefly discuss **three (3)** possible factors affecting the capacitance of a capacitor, **(b)** Two parallel plates of dimension **7.5 cm X 10 cm** are placed **2.5cm** apart in a medium of relative permittivity **3**. If this arrangement stores a charge of **7.9686pC**, determine the potential difference between the plates.

Q.A3: An inductor has a ferrite core of cross sectional area **1.0cm²**, relative permeability of **1000** and mean airgap length of **0.2cm**. A coil of **500 turns** carrying current of **4A** is wound on the core. Take the mean diameter of the core as **9cm**. Determine the following: **(i)** The magnetic flux density in the core, **(ii)** The inductance of the inductor.

SECTION B: ANSWER ANY TWO QUESTIONS FROM THIS SECTION INTO SCRIPT X

Q.B1: **(a)** State: (i) Kirchoff's Current Law; (ii). Kirchoff's Voltage Law

(b) Using Mesh method, obtain the currents I_1 and I_2 in Figure QB1.

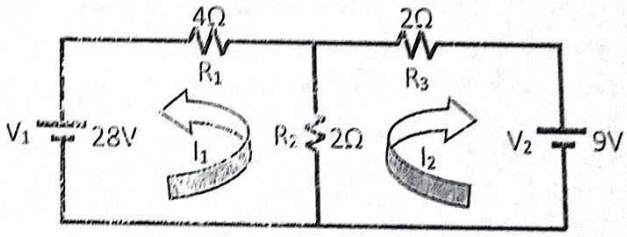

Figure Q.B1

Q.B2: **(a)** Define the following:(i) Circuit; (ii). Node; (iii). Branch; (iv) Loop; and (v). Mesh.

(b) Using nodal analysis, find the currents I_1, I_2 and I_3 in the circuit of Figure Q.B2.

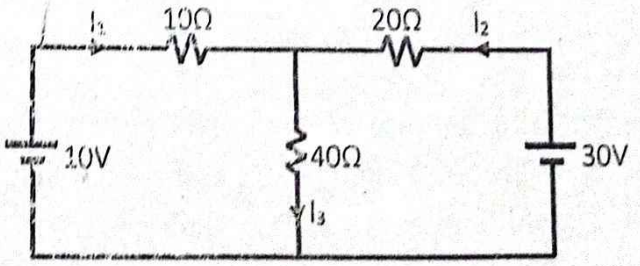

Figure Q.B2

Q.B3: **(a)** State the following: **(i)** Superposition theorem; **(ii)** Thevenin's theorem

(b) Applying Thevenin's theorem in Figure Q.B3, find the equivalent voltage V_{AB} and the equivalent current I_{eq} flowing through the Thevenin's equivalent circuit.

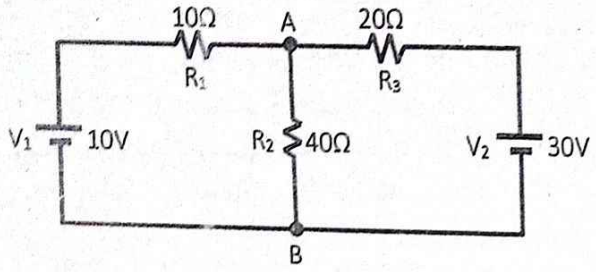

Figure Q.B3

SECTION C: ANSWER ANY TWO QUESTIONS FROM THIS SECTION INTO SCRIPT Y

Q.C1: Using the circuit shown below determine by star-delta transformation, the network resistance of Fig. Q.C1 as viewed from the battery terminals:

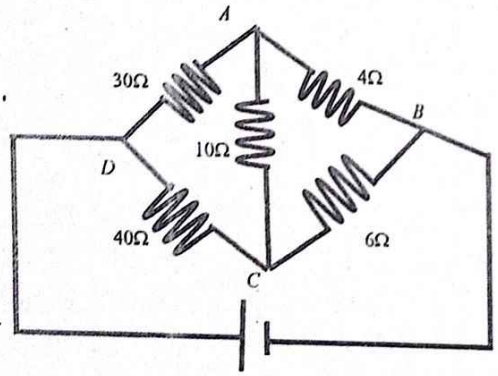

Fig. Q.C1

Q.C2: The primary of a transformer is rated at 10A. On open circuit test, the readings are V_1 = 1000V, V_2 = 500V, I_1 = 0.42A and P_{OC} = 100W. On short circuit, the readings are I_1 = 10A, V_1 = 126V and P_{SC} = 400W. Determine the parameters of the transformer and draw (with labels as determined) the approximate equivalent circuit with the shunt branch placed at the input terminals.

Q.C3: A 3-phase 400V motor load has a power factor of 0.50, two wattmeters connected to measure the power show the input to be 40kW. Find the reading on each wattmeter. Comment on the unexpected result, if any.

SECTION D: ANSWER ANY TWO QUESTIONS FROM THIS SECTION INTO SCRIPT Y

Q.D1: In Figure Q.D1, determine, **(i)** the current delivered by the ac source. **(ii)** the true power, reactive power and apparent power delivered to the series-parallel load.

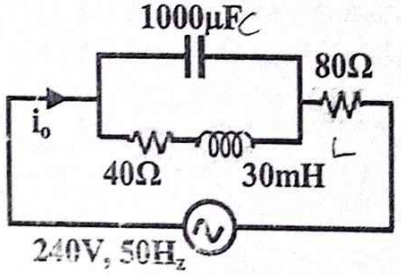

Figure Q.D1

Q.D2: **(a)** Find the resonant frequency, f_o, for the circuit shown in Figure Q.D2, **(b)** From your result, simplify f_o if $R_L = R_C = \sqrt{\frac{L}{C}}$

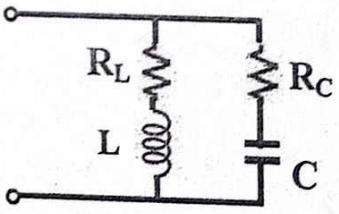

Figure Q.D2

Q.D3: For the electronic switch shown in Figure Q.D3, explain its switching operation with the help of its inherent $i_D - v_D$ characteristic curve.

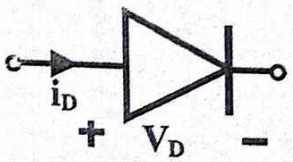

Figure Q.D3

DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF NIGERIA, NSUKKA
2014/15 FIRST SEMESTER EXAMINATIONS

EEE 211: ELECTRICAL ENGINEERING 1
ANSWER ANY FIVE QUESTIONS OF YOUR CHOICE
TIME ALLOWED: 3 HOURS

DO NOT WRITE ANYTHING ON THIS QUESTION PAPER

QUESTION 1

A 2kVA, 50Hz, power transformer has the following equivalent circuit parameters referred to the primary: $R_e = 0.682\Omega$, $X_e = 0.173\Omega$, $R_C = 1080\Omega$, $X_M = 657\Omega$ and $N_2/N_1 = 0.472$. If the primary is connected to a 230V, 50Hz supply and a load impedance of $(6.0 + j2.5\Omega)$ is connected to the secondary, determine (assuming the shunt branch is placed at the input terminals):

(a) the magnitude of the secondary current,
(b) the magnitude of the secondary terminal voltage,
(c) the magnitude of the primary current

QUESTION 2

(a) Draw and label the per-phase exact equivalent circuit of a transformer with all the parameters referred to the primary side.

(b) A 3300/230V single phase transformer has an equivalent resistance of 2.5Ω and equivalent leakage reactance of 8Ω. Find the secondary terminal voltage at full load and 0.8 power factor lagging if the primary terminal is fed with 3300V.

(c) Both no-load and short-circuit tests are important in determining parameters transformer. Copy and complete the table below as it pertains to a three-phase transform rated 300KVA:

OPEN CIRCUIT TEST	SHORT-CIRCUIT TEST
Name of the variables measured	Name of variables measured:
(i) Io	(vi)
(ii) Iron Loss	(vii)
(iii) Core loss	(viii)
Parameters calculated:	Parameters calculated:
(iv) Efficiency	(ix) efficiency
(v) Ro	(x) Regulation of transformer

QUESTION 3

Determine the current through the 10Ω resistor in Fig Q3 using Thevenin's Theorem.

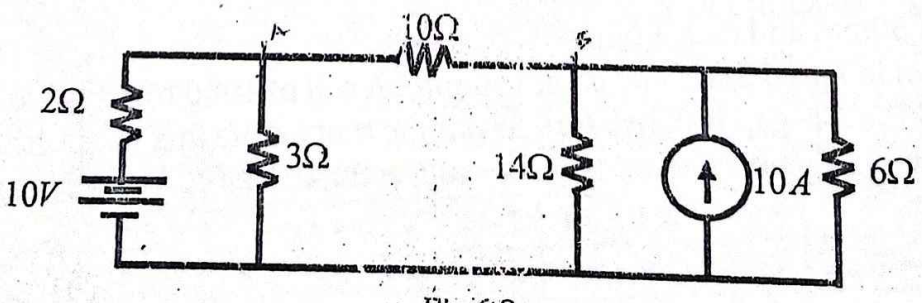

Fig Q3

QUESTION 4

Use nodal analysis method to determine V_1, V_2, and I in the circuit of Fig. Q4

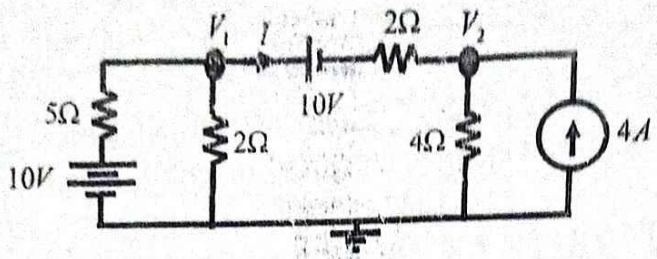

Fig. Q4

QUESTION 5

For the series RLC circuit shown in Fig Q5, determine (i) the rms current (ii) the real power (iii) the reactive power (iv) the apparent power drawn from the source. (v) Draw the power triangle.

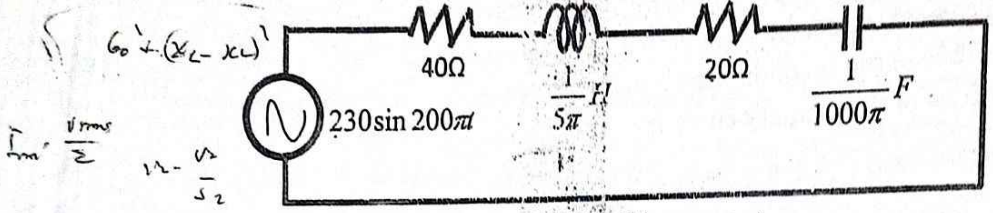

Fig. Q5

QUESTION 6

(a) With aid of diagrams only, illustrate the following biasing configurations for a BJT (i) Common Base (ii) Common Emitter (iii) Common Collector

(b) For the BJT circuit shown in Fig. Q6, determine as follows (i) I_C (ii) I_B (iii) I_E and V_{BE}. Take $V_{CE} = 0.7V$.

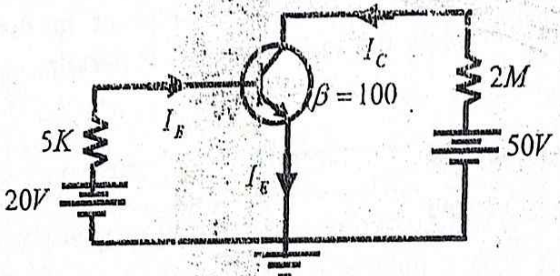

Fig. Q6

QUESTION 7

Determine the resultant force on 3μC charge due to -4μC and 10nC charges. All these three point charges are placed on the vertices of an equilateral triangle ABC of side 50cm

QUESTION 8

A magnetic circuit comprises three parts in series, each of uniform cross-sectional area (c.s.a). They are:

a) A length of 80mm and c.s.a. 50mm²
b) A length of 60mm and c.s.a. 90mm²
c) An air gap of length 0.5mm and c.s.a. 150mm². A coil of 4000 turns is wound on part (b), and flux density in the air- gap is 0.3wb/m². Assuming that all the flux passes through the given circuit, and that the relative permeability μr is 1300, estimate the coil current to produce such a flux density.

UNIVERSITY OF NIGERIA, NSUKKA
DEPARTMENT OF ELECTRICAL ENGINEERING
2017/18 END OF FIRST SEMESTER EXAMINATIONS

EEE 211: BASIC ELECTRICAL ENGINEERING I

TIME ALLOWED: 2 Hours 40 Minutes

While writing on a particular answer script, be sure to complete one section before the other

SECTION A: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'X'

QUESTION A1: (a) Sketch the torque-speed characteristics of (i) an AC induction motor and (ii) a Shunt dc motor. Indicate clearly on your sketches, the normal operating ranges. (b) Draw the equivalent circuit diagram of a series-connected dc motor. State one application of a series-connected dc motor. (c) A 20-hp shunt dc motor operates from a 200 V dc source with fixed losses of 1000 W under full-load conditions. The full-load speed is 1100 rpm. If on no-load conditions, the motor speed is 1150 rpm, find the input current, the motor efficiency under full load conditions, and the speed regulation.

QUESTION A2: A linear dc machine has a magnetic flux density of 0.3 T directed into the page, a resistance of 0.20 Ω, a bar length l = 0.8 m, and a source voltage of 80 V. (a) Draw the equivalent circuit diagram of the linear dc machine. (b) What is the starting current? (c) What is the magnitude and direction of the initial force on the bar at starting? (d) What is the no-load steady-state speed of the bar? (e) If the bar is loaded with a force of 15 N opposite to the direction of motion, what is the new steady state speed?

QUESTION A3: (a) An electrician on an inspection visit in a residential home at Nsukka found out that he wrongly took along with him a PMMC meter instead of an AC voltmeter. As a trainee engineer, what is the device that you will recommend to the electrician to incorporate into his PMMC meter to enable it measure voltage across an AC voltage source? How should the device be connected? Sketch the circuit diagram of the arrangement. Also **state the function** of the device in the arrangement. (b) An electrical engineering firm was contracted by EEDC to design a system that will enable the secondary winding voltage of a 500 kVA, 0.415 kV/11 kV step transformer at an embedded generation substation in UNN, to be measured using an AC voltmeter with range: 0-120 V. With a diagram, **show** the circuit arrangement that will enable the AC voltmeter to measure the secondary winding voltage of the transformer. **Assume** that the load across the secondary winding is a resistive load. **What** is the *name* and *function* of the device interfacing the AC voltmeter to the secondary winding terminals?

SECTION B: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'X'

QUESTION B1. Spheres A and B are equally charged but with opposite signs. If they experience a force (F) of 2.5×10^7 N when placed 3.0 cm apart, determine the charge on each of the spheres if the relative permittivity of the medium involved is 6.

QUESTION B2. Two equal and opposite charges, A and B of magnitude 2.0×10^{-7} are placed 20cm apart. Compute the magnitude and direction of Electric field intensity (E) at the mid-point M, between the charges. What force would act on an electron with a charge of -1.6×10^{-19}C if placed there?

QUESTION B3. A coil is wound uniformly with 600 turns over a steel ring of relative permeability 750 having a mean circumference of 0.4m and cross sectional area of $0.05m^2$. Suppose the coil has a resistance of 100Ω when connected to a 250V dc supply, calculate the: (i) mmf of the coil, (ii) field strength, (iii) total flux, (iv) reluctance of the ring and (v) permeance of the ring.

SECTION C: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'Y'

QUESTION C1: The following ordinates were taken during half-cycle of a symmetrical alternating current wave, the current varying in a linear manner between successive points as tabulated here.

Phase angle (degree)	15	30	45	60	75	90	105	120	135	150	165	180
Current (Amp)	3.6	8.4	14	19.4	22.5	25	25.2	23	15.6	9.4	4.2	0

Determine **(a)** the mean value, **(b)** the root mean square value, **(c)** the form and **(d)** peak factor.

QUESTION C2: Determine the dc resistance levels for the diode with the characteristic shown in Figure C2 at **(a)** $I_D = 2mA$; **(b)** $I_D = 20$ mA; **(c)** $V_D = -10$ V

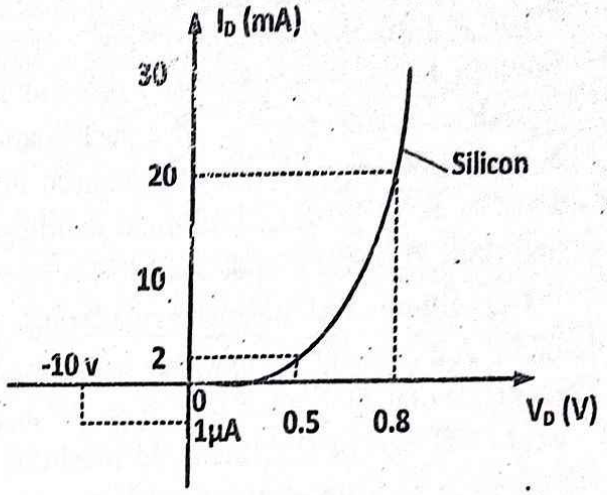

Figure C2

QUESTION C3: **(a)** The load of a single-phase 200/2500V, 50Hz transformer is a 200μF capacitor and is connected across the secondary terminals. If 185V is impressed on the input, what is the capacitance of this load capacitor as seen by this input voltage? **(b)** A loaded 50kVA ideal transformer has the secondary voltage as 2000V and primary current as 20A. What are the values of primary voltage and secondary current? **(c)** Is the transformer of (b) above a step-up or step-down?

SECTION D: ANSWER ANY TWO QUESTIONS INTO THE ANSWER SCRIPT MARKED 'Y'

QUESTION D1: A 3-phase, 100kVA, 2000/200V transformer whose parameters are given as: $R_1 = 2\Omega$; $R_2 = 0.2\ \Omega$; $X_1 = 2\Omega$; $X_2 = 0.5\Omega$; $X_m = 23\Omega$ and $R_C = 20\Omega$; $Z_L = 4 + j3.5$. **(a)** Draw the actual per-phase equivalent circuit of the transformer, labelling all the parameters. **(b)** Draw the approximate equivalent circuit with all the low voltage parameters calculated and referred to the high voltage side.

QUESTION D2: From the source free circuit shown in Fig. D2, calculate: **(a)** the voltage across the **25Ω** resistor. **(b)** the current flowing **25Ω**, if the initial combined capacitor voltage, Vc (0)= 35V.

QUESTION D3: Using Thevenin's method, calculate the maximum power transferred to load R_L, of Fig. D3.

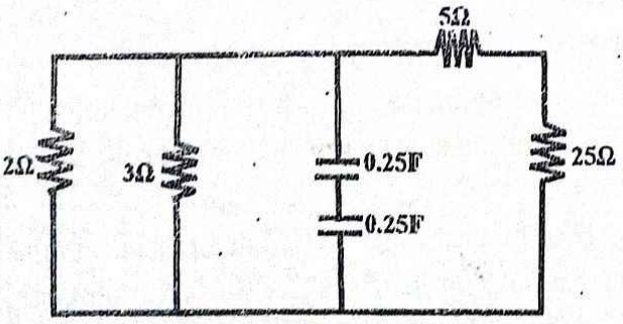

Fig. D2

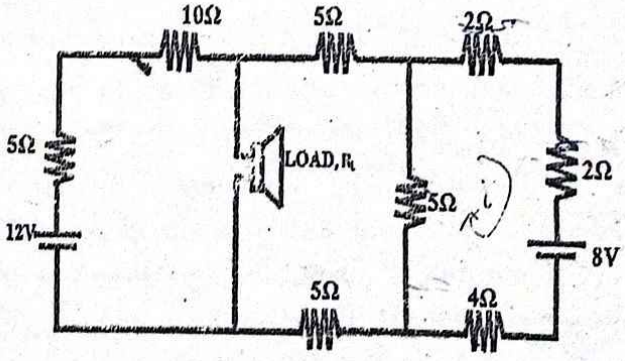

Fig. D3