2018/2019 SEMESTER 2 EXAMINATION

Diploma in Aerospace Electronics (DASE)
Diploma in Computer Engineering (DCPE)
Diploma in Engineering with Business (DEB)
Diploma in Electrical & Electronic Engineering (DEEE)
Diploma in Engineering Systems (DES)
Diploma in Energy Systems & Management (DESM)
Common Engineering Programme (DCEP)
1st Year FT

PRINCIPLES OF ELECTRICAL & ELECTRONIC ENGINEERING I (PEEEI)

Time Allowed: 2 Hours

Instructions to Candidates

1. The examination rules set out on the last page of the answer booklet are to be complied with.

2. This paper consists of **TWO** sections:
   Section A - 10 Multiple Choice Questions, 2 marks each.
   Section B - 8 Short Questions, 10 marks each.

3. **ALL** questions are **COMPULSORY**.

4. **All questions are to be answered in the answer booklet**. Start each question in Section B on a new page.

5. Fill in the Question Numbers, in the boxes found on the front cover of the answer booklet under the column "Questions Answered".

6. This paper contains **11** pages, inclusive of formulae sheet.

SECTION A

MULTIPLE CHOICE QUESTIONS (20 marks)

1. Please **tick** your answers in the **MCQ box** on the inside of the front cover of the answer booklet.

2. No marks will be deducted for incorrect answers.

A1. The total capacitance of the circuit as shown in Figure A1 is

(a) 3μF
(b) 3.25μF
(c) 6.5 μF
(d) 12 μF

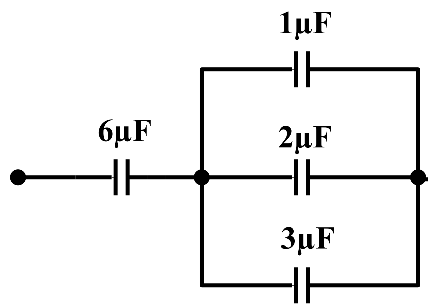

Figure A1

A2. If a conductor is moved back and forth at a constant rate in a constant magnetic field, the induced voltage in the conductor will

(a) be increased
(b) reverse polarity
(c) be reduced
(d) remain constant

A3. The current flowing through a 50 mH pure inductor is dc 50 mA. The induced voltage across the inductor during this period of 50 ms is

(a) 0 mV
(b) 50 mV
(c) 500 mV
(d) 50 V

A4. A sudden decrease in the total current into a parallel circuit may indicate

(a) a short
(b) a drop in source voltage
(c) an open resistor
(d) either (b) or (c)

A5. Which one of the following statements is **FALSE**?

(a) the higher the permeability, the more easily a magnetic field can be established.
(b) the value of reluctance is inversely proportional to length (l) of the magnetic path.
(c) the ability to maintain a magnetized state without the presence of a magnetizing force is known as retentivity.
(d) the magnetizing force that required to remove the retentivity and make flux density zero is known as coercive force.

A6. If the peak voltage of a fully rectified sine wave is 100 V, its average value is

(a) 100 V
(b) 50 V
(c) 63.7 V
(d) 31.8 V

A7. Which of the following parameters does NOT affect the magnetizing force?

(a) type of material used
(b) length of the material
(c) current flowing through the coil
(d) number of turns wind round the material

A8. Select the series RL circuit that has the **smallest** time constant

(a) R = 100 Ω, L = 50 mH
(b) R = 4.7 kΩ, L = 100 mH
(c) R = 10 MΩ, L = 50 mH
(d) R = 1 kΩ, L = 100 mH

A9. If 10 W of power is applied to the primary of an ideal transformer with a turns ratio of 5, the power delivered to the load is

(a) 0 W
(b) 5 W
(c) 10 W
(d) 50 W

A10. If the current flowing through a 1 mH coil is changing at a rate of 0.2 kA/s, the induced voltage across the coil is

(a) 0.2 μV
(b) 0.2 mV
(c) 0.2 V
(d) 0 V

SECTION B

SHORT QUESTIONS (80 marks)

B1. Using the Superposition Theorem, determine the current I_3 flowing through R_3 as shown in Figure B1. (10 marks)

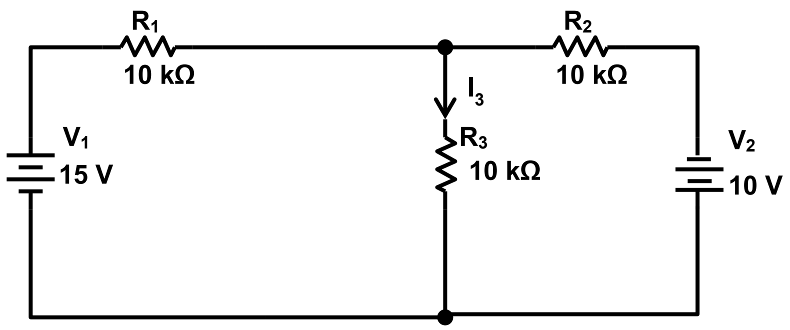

Figure B1

B2. An ac voltage of 220 V is applied to the primary side of a transformer. Its secondary voltage of 22 V is connected to a resistive load. The transformer has 500 turns in its primary winding. Its secondary current is 1 A. Determine

(a) the turns ratio (2 marks)
(b) the number of turns in its secondary winding (2 marks)
(c) the primary current (2 marks)
(d) the resistance of the resistive load (2 marks)
(e) the power dissipated in the resistive load. (2 marks)

B3. With reference to Figure B3 calculate:

(a) the total capacitance C_T (2 marks)
(b) the total charge stored by the series capacitors (2 marks)
(c) the voltage across each capacitor. (6 marks)

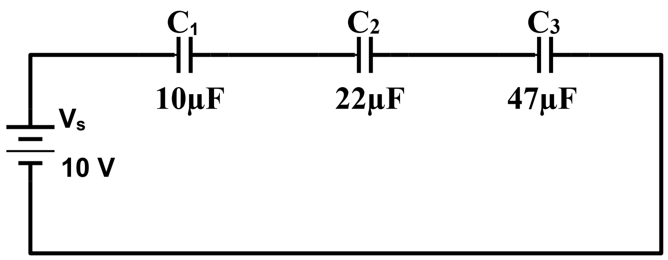

Figure B3

B4. With reference to Figure B4,

(a) Determine the voltage V_3 (3 marks)

(b) Determine the current I_S (4 marks)

(c) If the voltage source V_S=30V is replaced with a current source I_S=8A, determine the new value for V_3 in Figure B4 (3 marks)

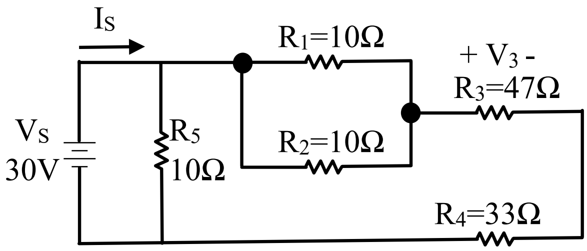

Figure B4

B5. A sinusoidal voltage of $V_{s(rms)}$ = 100 V is applied to the circuit as shown in Figure B5. Calculate:

(a) the total peak supply current $I_{s(peak)}$ (4 marks)

(b) the peak-to-peak voltage across R_2 (3 marks)

(c) the peak current flowing through R_3. (3 marks)

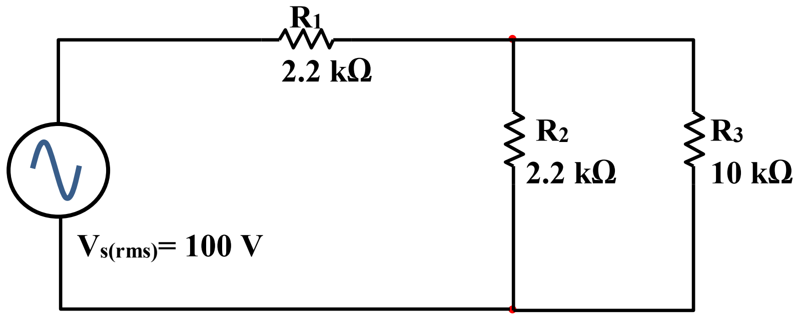

Figure B5

B6. (a) Determine the total inductance of the circuit in Figure B6. (4 marks)

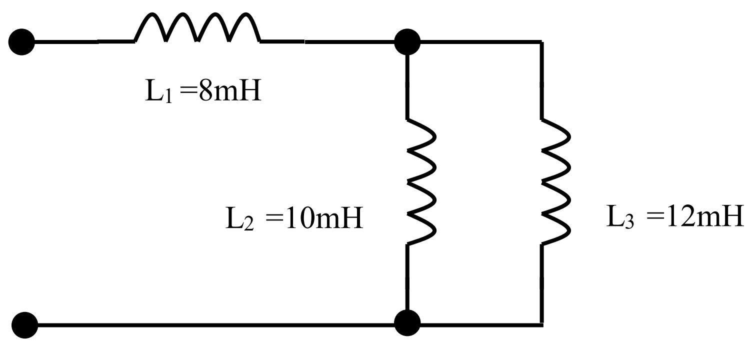

Figure B6

(b) If a voltage of 10 kV is induced in an inductor by a current changing at a rate of 5 x 10^6 A/s, find the value of this inductor. (3 marks)

(c) Calculate the value of a second inductor that is required to be connected in parallel to a 10 mH inductor in order to produce a total inductance of 3 mH. (3 marks)

B7. (a) Determine the maximum and minimum voltage across R in Figure B7. (4 marks)

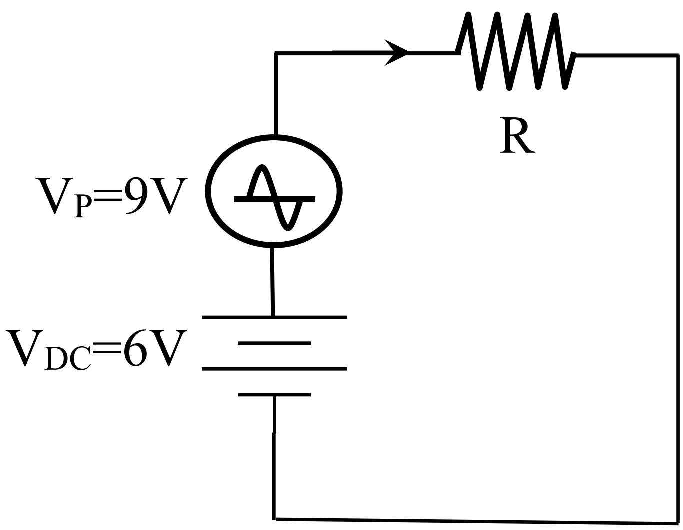

Figure B7

B7. (b) A 20 kΩ resistor is connected in series to a 0.2 μF capacitor, a switch and a 15V DC voltage source. The capacitor is leakage-free and was initially uncharged. The switch was initially open and was closed at t = 0 second. Determine the following:

(i) Time constant (τ) of the RC circuit. (2 marks)

(ii) Voltage across the capacitor at t = 3ms. (2 marks)

(iii) Voltage across the resistor after t = 5τ seconds. (2 marks)

B8. Refer to Figure B8, the magnetic material has a relative permeability, μ_r, of 820. Its overall length of the magnetic path is 0.16 m and its cross-sectional area is 0.012 m^2. The coil has 840 turns and carries a dc current of 350 mA. Determine:

(a) The permeability (μ) of the material. (2 marks)

(b) The reluctance ($\mathcal{R}$) of the magnetic circuit. (3 marks)

(c) Total flux (Φ) generated. (3 marks)

(d) The magnetising force. (2 marks)

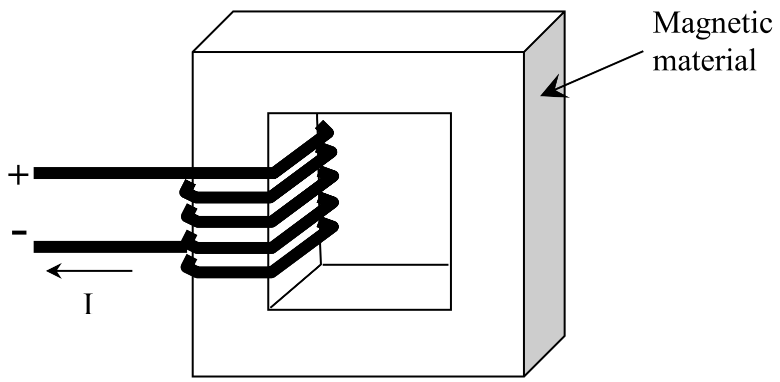

Figure B8

- End of Paper -

Formulae List

Resistors:

$R = \frac{\rho l}{A}$

Resistance in series, $R_T = R_1 + R_2 + \ldots\ldots\ldots + R_n$

Resistance in parallel, $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$ for n resistors

Resistance in parallel, $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$ for 2 resistors

Power dissipation in resistor, $P = VI$ $\quad P = I^2R$ $\quad P = \frac{V^2}{R}$

Energy, Work Done, Charge, Power:

$W = QV$ $\quad P = \frac{W}{t}$ $\quad I = \frac{Q}{t}$

6.25×10^{18} electrons ➔ 1C of negative charge

Ohm's Law:

$V = IR$ $\quad I = \frac{V}{R}$ $\quad R = \frac{V}{I}$

Kirchhoff's Voltage Law:

$\sum$ Voltage rises = $\sum$ Voltages drops in a closed circuit.

Kirchhoff's Current Law:

$\sum$ Incoming currents = $\sum$ Outgoing currents at a node

Voltage Divider Rule:

$V_x = \frac{R_x}{R_T} V_s$

Current Divider Rule:

Branch current $I_x = \frac{R_T}{R_x} I_T$ for any number of parallel branches

$I_1 = \frac{R_2}{R_1 + R_2} I_T$ **or** $I_2 = \frac{R_1}{R_1 + R_2} I_T$ for **2** parallel branches only

Capacitors:

Q(coulombs) = V(volts) x C(farads)

Energy Storage, W = ½ C V^2 (Joules)

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m $\varepsilon = \varepsilon_o \varepsilon_r$

Capacitance $= \frac{\text{Area (A)} \times \varepsilon}{\text{distance (d)}}$ Farad

Increasing exponential voltage v(t) = $V_F\ (1 - e^{\frac{-t}{RC}})$

Decreasing exponential voltage v(t) = $V_i\ e^{\frac{-t}{RC}}$

Total capacitance for "n" capacitors in series, $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$

Total capacitance for "n" capacitors in parallel, $C_T = C_1 + C_2 + \cdots + C_n$

Magnetism & Electromagnetism:

$$\text{Flux } (\phi) = \frac{\text{Magnetomotive force } (\mathcal{F}_m, \text{At})}{\text{Reluctance } (\mathcal{R}, \text{At/Wb})} \text{ Weber (Wb)}$$

$$\text{Flux density, B} = \frac{\text{Flux } (\phi, \text{Wb})}{\text{Area perpendicular to flux } (\text{A, m}^2)} \text{ Tesla (T)}$$

Magnetomotive Force ($\mathcal{F}_m$) = N (number of turns) x I (Current, A)

$$\text{Magnetising force (H)} = \frac{\mathcal{F}_m}{\text{length of material } (l, m)} \text{At/m}$$

$$\text{Reluctance } (\mathcal{R}) = \frac{\text{length } (l, m)}{\text{permeability } \left(\mu, {}^{\text{Wb}}/_{\text{At. m}}\right) \text{x crosssection area } (\text{A, m}^2)} \text{At/Wb}$$

$\mu_o = 4\pi \times 10^{-7}$ Wb/At.m $\mu = \mu_o \mu_r$

Inductors:

Voltage induced in a coil due to current changes, $e(t) = L\frac{di(t)}{dt}$

Voltage induced in a coil due to flux changes, $e(t) = N\frac{d\Phi(t)}{dt}$

Energy Storage, $W = \frac{1}{2} L I^2$ (Joules)

Inductance, $L = \frac{N^2 \mu A}{l}$ (Henry)

Increasing exponential current in an inductor $i(t) = I_F\,(1 - e^{\frac{-Rt}{L}})$

Decreasing exponential current in an inductor $i(t) = I_i\, e^{\frac{-Rt}{L}}$

for "n" inductors in series, $L_T = L_1 + L_2 + \ldots\ldots\ldots + L_n$

for "n" inductors in parallel, $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_n}$

Transformer:

$\frac{V_p}{V_s} = \frac{N_p}{N_s}$, $\frac{I_s}{I_p} = \frac{N_p}{N_s}$, $V_p I_p = V_s I_s$ = transformer rating

$k = \frac{\phi_{1-2}}{\phi_1}$, $L_M = k\sqrt{L_1 L_2}$, Turns ratio $n = \frac{N_s}{N_p}$

AC Voltages and Currents:

$I_{rms} = I_p / \sqrt{2} = 0.7071\, I_p$	$I_{p\text{-}p} = 2I_p$	$I_{av} = 2I_p/\pi = 0.637 I_p$
$V_{rms} = V_p / \sqrt{2} = 0.7071\, V_p$	$V_{p\text{-}p} = 2V_p$	$V_{av} = 2V_p/\pi = 0.637 V_p$

Answers to 2018/2019 SEMESTER 2 EXAMINATION

A1 a A2 b A3 a A4 d A5 b A6 c A7 a A8 c A9 c A10 c

B1 0.1667 mA

B2 (a) 0.1 (b) 50 (c) 0.1 A (d) 22 Ω (e) 22 W

B3 (a) 6 μF (b) 60 μC (c) V_1 = 6 V, V_2 = 2.727 V, V_3 = 1.277 V

B4 (a) 16.58 V (b) 3.353 A (c) 39.58 V

B5 (a) 35.33 mA (b) 127.4 V (c) 6.371 mA

B6 (a) 13.46 mH (b) 2 mH (c) 4.286 mH

B7 (a) V_{max} = 15 V, V_{min} = -3V (b) (i) 4 ms (ii) 7.915 V (iii) 0 V

B8 (a) 1.03 m Wb/At.m (b) 12 939 At/Wb (c) 22.72 mWb (d) 1838 At/m