2018/2019 SEMESTER 1 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. If 10 W of power are applied to the primary winding of an ideal transformer with a turns ratio of 50, the power delivered to the secondary load is

(a) 5 W
(b) 10 W
(c) 50 W
(d) 500 W (2 marks)

A2. Select the series RC circuit that has the **lowest** time constant

(a) R = 4.7 kΩ, C = 2 μF
(b) R = 100 Ω, C = 1 μF
(c) R = 10 MΩ, C = 5 pF
(d) R = 1 kΩ, C = 10 μF (2 marks)

A3. In Figure A3, the capacitor is initially uncharged. The switch is initially open and then closed at t = 0s. At the instant when the switch is closed at t = 0s, the current flowing through the resistor is

(a) 0 mA
(b) 1 mA
(c) 10 mA
(d) 100 mA (2 marks)

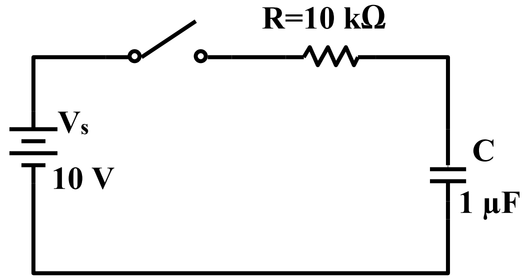

Figure A3

A4. The sinusoidal voltage and current in an AC circuit are represented by the following expressions:

$$v(t) = 10 \sin(100\pi t + 60^0)\text{V}$$
$$i(t) = 2 \sin(100\pi t - 15^0)\text{A}.$$

Which one of the following statement is true?

(a) i(t) leads v(t) by 45^0
(b) i(t) lags v(t) by 45^0
(c) i(t) leads v(t) by 75^0
(d) i(t) lags v(t) by 75^0 (2 marks)

A5. A transformer has a turns ratio of 5 and a coupling coefficient of 0.8 between the primary and secondary coil. The inductances of the primary and secondary coils are 10 mH and 40 mH respectively. Calculate the mutual inductance, L_M between the 2 coils.

(a) 8 mH
(b) 12 mH
(c) 16 mH
(d) 20 mH (2 marks)

A6. If the switch is closed in Figure A6, determine the resulting current drawn from the supply?

(a) 0 mA
(b) 2.5 mA
(c) 3.33 mA
(d) 5 mA (2 marks)

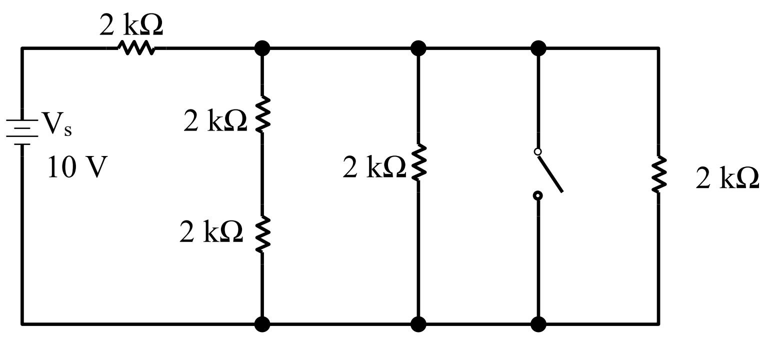

Figure A6

A7. Which one of the following copper wire has the **highest** resistance?

(a) 10 metre wire of cross sectional area of 1 mm^2
(b) 10 metre wire of cross sectional area of 5 mm^2
(c) 5 metre wire of cross sectional area of 1 mm^2
(d) 5 metre wire of cross sectional area of 5 mm^2

(2 marks)

A8. The following table shows the elements A, B, C and D and their respective number of valence electrons. Which elements are in the **good conductor** category?

Element	A	B	C	D	E
Number of valence electrons	1	2	4	5	6

(a) A and B
(b) B and C
(c) C and D
(d) D and E (2 marks)

A9. A coil of 1200 turns give rise to a magnetic flux of 400 μWb when carrying a certain current. If this current is reversed in 0.1 s, what is the average value of induced voltage in the coil?

(a) 4.8 V
(b) 9.6 V
(c) 48 V
(d) 96 V (2 marks)

A10. A coil has a current changing at a rate of 1.1×10^{-6} A/s flowing through it. The induced voltage measured across the coil is 5.5 nV, what is the inductance of the coil?

(a) 5 pH
(b) 5 nH
(c) 5 μH
(d) 5 mH (2 marks)

SECTION B

SHORT QUESTIONS (80 marks)

B1. With reference to Figure B1, calculate:

(a) the total supply current I_s; (4 marks)
(b) the voltage at point A with respect to ground (V_A); (2 marks)
(c) the voltage at point B with respect to ground (V_B); (2 marks)
(d) the voltage V_{AB}. (2 marks)

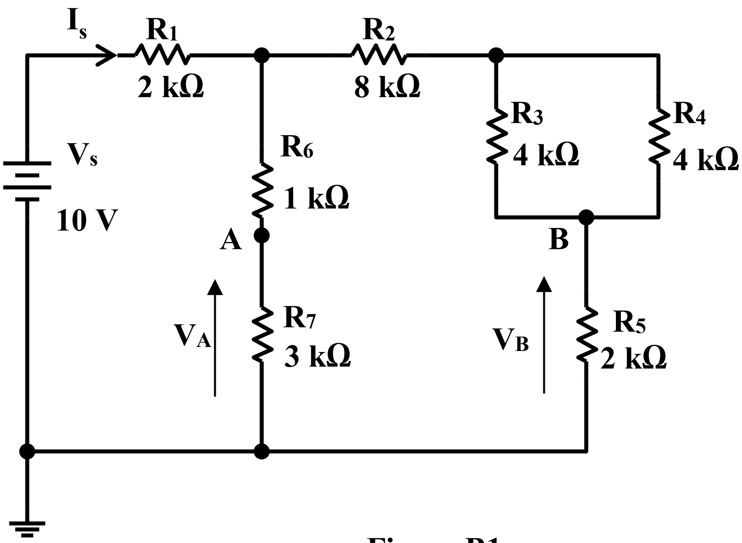

Figure B1

B2. Using the Superposition Theorem, determine the current I_3 flowing through R_3 as shown in Figure B2. (10 marks)

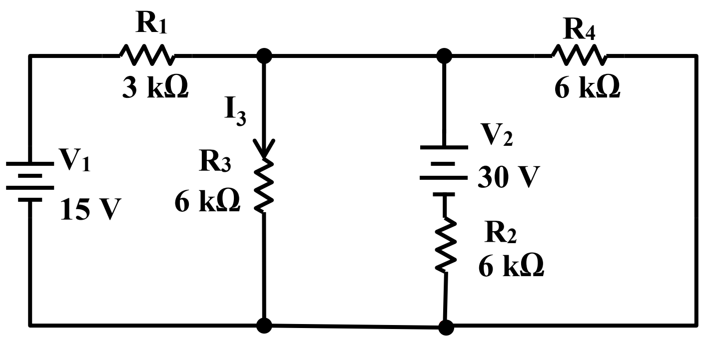

Figure B2

B3. An ac voltage of 230 V is connected to the primary side of a transformer and its secondary voltage of 10 V is connected to a resistive load of 5 Ω. The transformer has 100 turns in its secondary winding. Determine

(a) the turn ratio and the number of turns in the primary winding; (4 marks)
(b) the secondary and primary currents; (4 marks)
(c) the power dissipated in the resistive load. (2 marks)

B4. With reference to Figure 4, determine:

(a) the value of R_2; (6 marks)
(b) the total power dissipation; (2 marks)
(c) the supply current I_s, if R_2 is shorted. (2 marks)

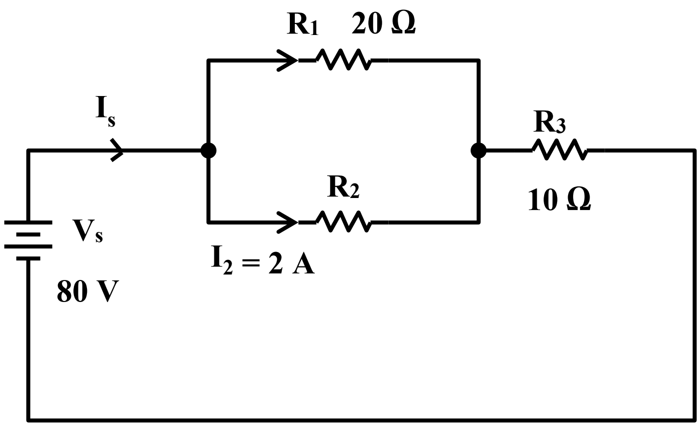

Figure B4

B5. A 2000-turn coil is wound on a cast iron core with a cross sectional of 8 cm^2 and a magnetic path length of 18 cm. The relative permeability of the cast iron is 280. Calculate:

(a) the inductance, L, of the coil; (5 marks)
(b) the voltage induced across the coil if the current in it increases from zero to 20 mA in a time of 2 μs; (3 marks)
(c) the stored energy if the current flowing the coil is constant at 20 mA. (2 marks)

B6. With reference to Figure B6, calculate:

(a) the total capacitance C_T; (4 marks)
(b) the charge stored in C_4; (4 marks)
(c) the voltage across C_3. (2 marks)

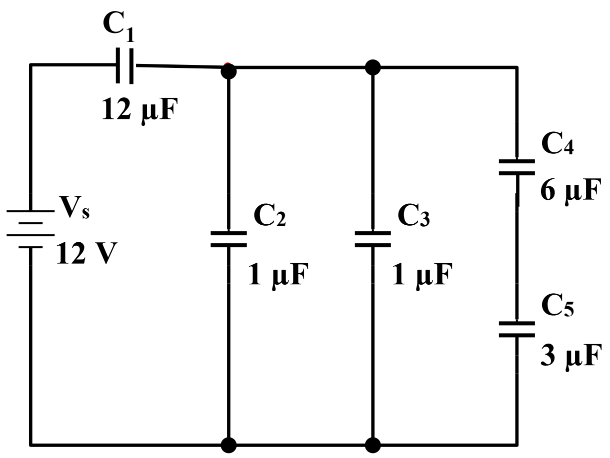

Figure B6

B7. Figure B7 shows a magnetic material with a uniform cross-sectional area of 18 cm^2 and its magnetic path length is 0.3 m. The coil has 1200 turns and carries a dc current of 2 A. The relative permeability of the magnetic material $\mu_r = 380$, calculate:

(a) the magnetising force; (2 marks)
(b) the reluctance of the magnetic material; (3 marks)
(c) the total flux generated; (3 marks)
(d) the flux density. (2 marks)

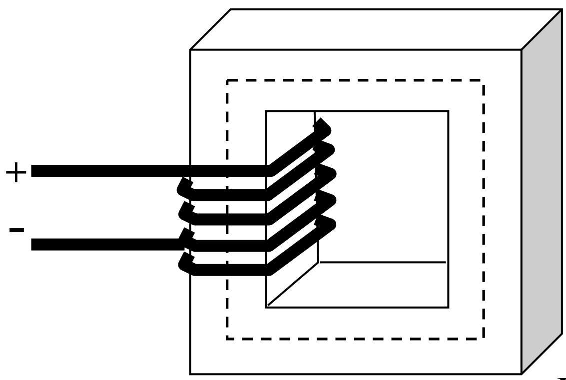

Figure B7

B8. For the circuit shown in Figure B8, calculate:

(a) the frequency and period of the supply voltage (v_s); (2 marks)

(b) the rms value of the supply current (I_s); (4 marks)

(c) The peak-to-peak voltage across resistor R_2. (4 marks)

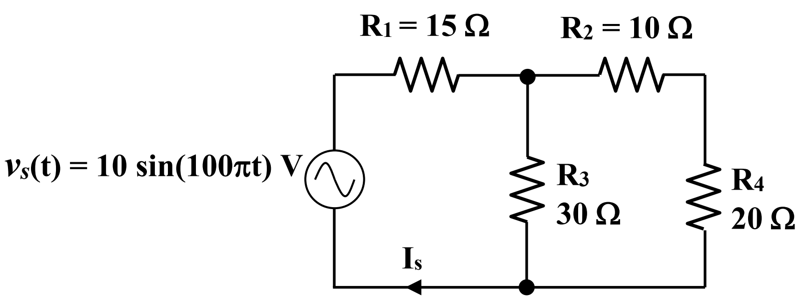

Figure B8

- End of Paper -

ET1005 2018/2019 Sem 1 Exams Answers *(these will not be provided in the actual Exams)*

Section A

1 b 2 c 3 b 4 d 5 c 6 d 7 a 8 a 9 b 10 d

Section B

B1 (a) 2 mA (b) 4.5 V (c) 1 V (d) 3.5 V

B2 2 mA

B3 (a) 0.0435 ; 2300 (b) I_S = 2 A; I_P = 0.087 A (c) 20 W

B4 (a) 20 Ω (b) 320 W (c) 8 A

B5 (a) 6.255 H (b) 62.55 kV (c) 1.251 mJ

B6 (a) 3 μF (b) 18 μC (c) 9 V

B7 (a) 8000 At/m (b) 349024 At/Wb (c) 6.876 mWb (d) 3.82 T

B8 (a) 50Hz; 20 ms (b) 0.2357 A (c) 3.33 V

Formulae List

Resistors:

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

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

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, $W = \frac{1}{2} C V^2$ (Joules)

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

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:

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

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

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

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

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

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

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, $L_T = L_1 + L_2 + \dots\dots\dots + L_n$

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

Transformer:

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

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

AC Voltages and Currents:

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