2017/2018 SEMESTER ONE EXAMINATION

Diploma in Aerospace Electronics (DASE) 1st Year FT
Diploma in Energy Systems and Management (DESM) 1st Year FT
Diploma in Computer Engineering (DCPE) 1st Year FT
Diploma in Electrical & Electronic Engineering (DEEE) 1st Year FT
Common Engineering Programme (DCEP) 1st Year FT
Diploma in Engineering with Business (DEB) 2nd Year FT

PRINCIPLES OF ELECTRICAL & ELECTRONIC ENGINEERING II

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.

5. Start each question in Section B on a new page.

6. Fill in the Question Numbers, in the order that they were answered, in the boxes found on the front cover of the answer booklet under the column "Questions Answered".

7. This paper contains 10 pages, inclusive of formulae sheets.

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. When the thermal energy in an intrinsic semiconductor material increases,

(a) the number of electron-hole pairs in the material increases.
(b) the majority charge carriers in the material increases.
(c) the majority charge carriers in the material decreases.
(d) the number of electron-hole pairs in the material decreases.

A2. When a reverse biased voltage is applied across a p-n junction, the depletion layer will

(a) reduce.
(b) remain the same.
(c) disappear.
(d) widen.

A3. When a 60 Hz sinusoidal voltage is applied to the input of a half-wave rectifier, the output frequency is equal to

(a) 30 Hz
(b) 50 Hz
(c) 60 Hz
(d) 120 Hz

A4. Which one of the following devices is NOT a transducer?

(a) Thermistor
(b) Light dependent resistor
(c) Silicon diode
(d) Moisture sensor

A5. Which one of the following IC voltage regulators gives a DC output voltage of +6 V?

(a) 7806
(b) 7812
(c) 7906
(d) 7912

A6. For the circuit shown in Figure A6, the current I in the silicon diode is equal to

(a) 1.22 mA
(b) 1.83 mA
(c) 3.65 mA
(d) 5.49 mA

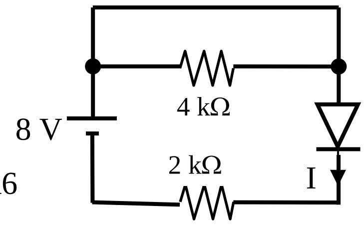

Figure A6

A7. For the transistor circuit shown in Figure A7, the base current I_B is equal to

(a) 0.192 mA
(b) 0.25 mA
(c) 0.583 mA
(d) 0.833 mA

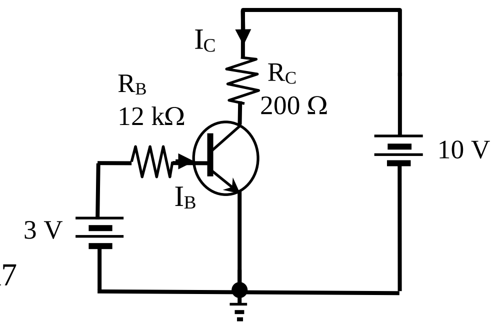

Figure A7

A8. For the transistor shown in Figure A7, which one of the following layers have electrons as the majority carrier?

(a) Collector and base layers
(b) Emitter, collector and base layers
(c) Emitter and base layers
(d) Emitter and collector layers

A9. The Zener regulator circuit shown in Figure A9 operates at a Zener voltage of 2.8 V. The load current I_L is equal to

(a) 1.11 mA
(b) 3.5 mA
(c) 18.5 mA
(d) 22 mA

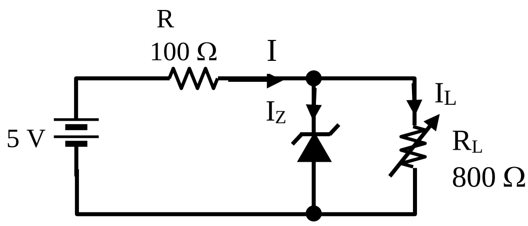

Figure A9

A10. If the reverse biased current in a Zener diode decreases from -25 mA to -55 mA and the Zener voltage changes from -6 V to -6.15 V correspondingly, the Zener impedance is equal to

(a) 0.2 Ω
(b) 5 Ω
(c) 112 Ω
(d) 240 Ω

SECTION B

SHORT QUESTIONS (80 marks)

B1. The automatic lighting circuit shown in Figure B1 has the following parameters:

Resistance of the light dependent resistor R_{LDR} ranges from 2 kΩ to 50 kΩ.
The DC current gain of the transistor, $\beta_{DC} = 300$.
The forward biased voltage drop across the LED, $V_{LED} = 1.9$ V.

(a) State the condition which will cause the resistance of the light dependent resistor, $R_{LDR} = 50$ kΩ. (2 marks)

(b) When $R_{LDR} = 50$ kΩ, the voltage across the LDR, $V_{LDR} = 4.5$ V, calculate

(i) the base current I_B; (2 marks)

(ii) the collector current I_C (Given that the transistor is biased in the active region); (2 marks)

(iii) the collector-emitter voltage V_{CE}. (4 marks)

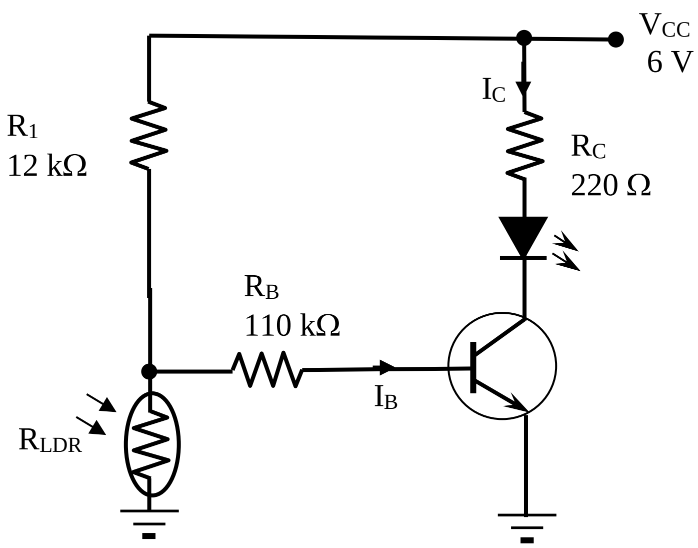

Figure B1

B2. (a) Figure B2-A shows the output voltage waveform across a filter connected to the output of a rectifier. Calculate the ripple factor of the filtered output. (4 marks)

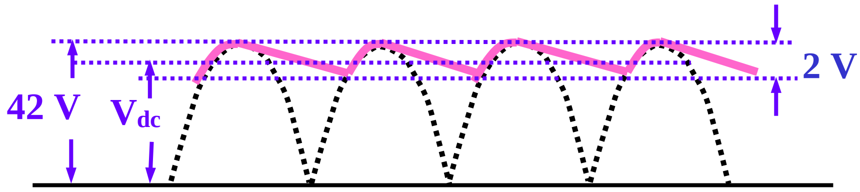

Figure B2-A

(b) For the circuit shown in Figure B2-B,

(i) sketch the voltage waveform V_D across the silicon diode. Indicate the maximum and the minimum values; (3 marks)

(ii) sketch the output voltage waveform across the resistor R. Indicate the maximum and the minimum values. (3 marks)

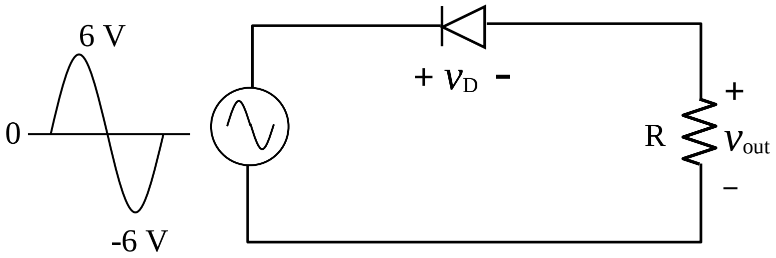

Figure B2-B

B3. For the circuit shown in Figure B3,

(a) calculate the peak output voltage $V_{out1(p)}$; (4 marks)
(b) calculate the peak output voltage $V_{out2(p)}$; (2 marks)
(c) sketch the output waveform v_{out2} and indicate the voltage levels; (2 marks)
(d) draw a circuit to be connected to v_{out2} such that its output is inverted i.e $-v_{out2}$. (2 marks)

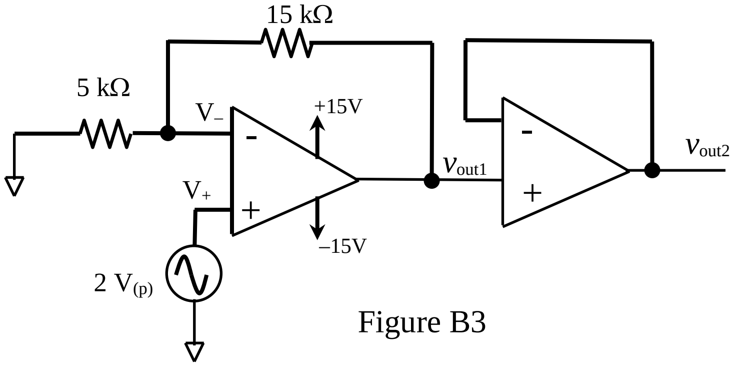

Figure B3

B4. For the circuit shown in Figure B4,

(a) identify the circuit; (2 marks)

(b) calculate the reference voltage V_{Ref}; (4 marks)

(c) draw the input waveform and the output waveform across R_L. Indicate the voltage levels. (4 marks)

Assume $+V_{sat}$ = 10 V and $-V_{sat}$ = -10 V

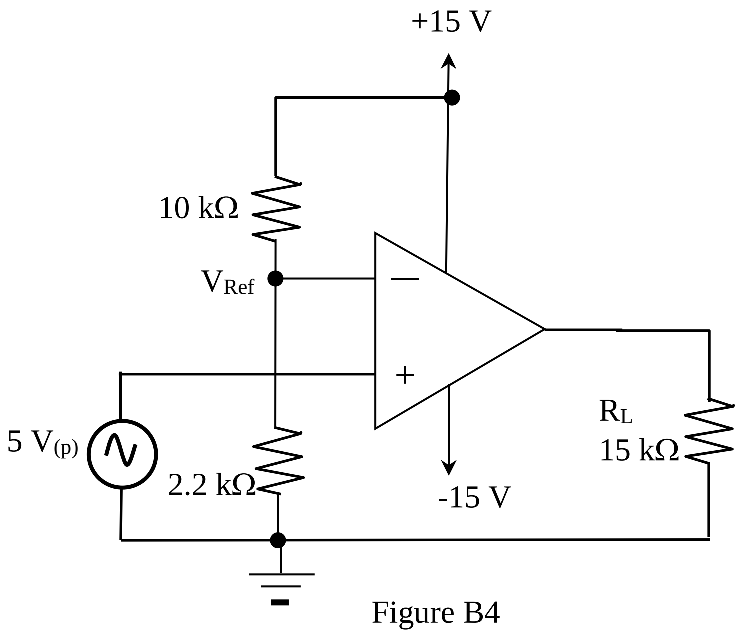

Figure B4

B5. The expressions for the three voltage sources in Figure B5 are $v_{S1}(t) = 22\sin(\omega t)$ V, $v_{S2}(t) = 16\sin(\omega t - 25^o)$ V and $v_{S3}(t) = 20\sin(\omega t + 50^o)$ V respectively.

(a) Find the total voltage V_T in polar form. (6 marks)

(b) Find the circuit current I in polar form. (2 marks)

(c) Write down the time-domain sinusoidal equation for the circuit current. (2 marks)

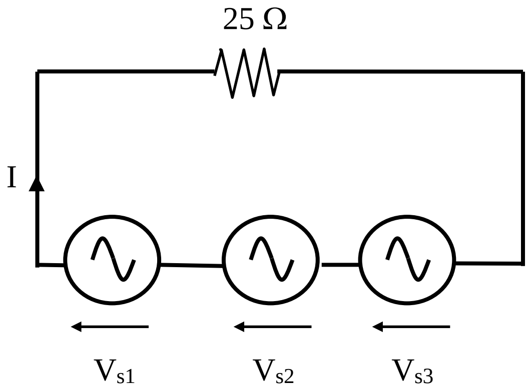

Figure B5

B6. For the circuit shown in Figure B6, if the current I is $15\angle{-45^o}$ A, calculate

(a) the total impedance Z in polar form; (2 marks)

(b) the power factor; (2 marks)

(c) the reactive and apparent power; (4 marks)

(d) the inductance L. (2 marks)

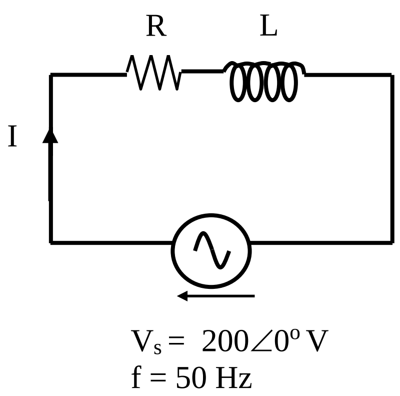

Figure B6

B7. Calculate the currents, I_R, I_L, I_C and I_T in Figure B7. (10 marks)

Express all your answers in polar form.

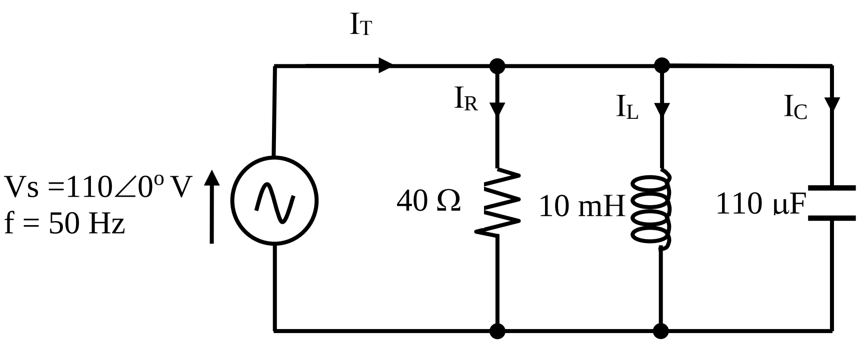

Figure B7

B8. For the circuit shown in Figure B8, calculate

(a) the total impedance Z in polar form; (2 marks)

(b) the circuit current I in polar form; (2 marks)

(c) the voltages V_R and V_L in polar form; (4 marks)

(d) draw the phasor diagram of V_S and I. (2 marks)

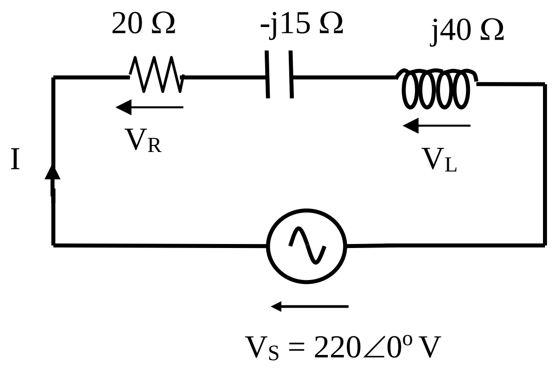

Figure B8

- End of Paper -

Formulae List

The maximum number of electrons in a shell (band) = $2N^2$

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

Ohm's Law for ac:

$$\overline{V} = \overline{I}\overline{Z} \qquad \overline{I} = \frac{\overline{V}}{\overline{Z}} = \overline{V}\overline{Y} \qquad \overline{Z} = \frac{\overline{V}}{\overline{I}}$$

Capacitors:

Capacitive reactance, $X_C = \dfrac{1}{2\pi fC}$ in ohms

Inductors:

Inductive reactance, $X_L = 2\pi f L$ in ohms

AC Voltages and Currents:

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

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

AC Impedance/Admittance:

Series circuit,

$$\overline{Z}_R = R \qquad \overline{Z}_C = -jX_C = -j\frac{1}{\omega C} = \frac{1}{\omega C}\angle -90^o \qquad \overline{Z}_L = jX_L = j\omega L = \omega L\angle 90^o \qquad \omega = 2\pi f$$

$$\overline{Z} = \overline{Z}_1 + \overline{Z}_2 + \overline{Z}_3 + ... \qquad \phi = \angle\overline{Z} = \angle\overline{I} = \tan^{-1}\frac{X_{tot}}{R_{tot}}$$

Parallel circuit,

$$\overline{Y}_R = G \qquad \overline{Y}_C = jB_C = j\omega C = \omega C\angle 90^o \qquad \overline{Y}_L = -jB_L = -j\frac{1}{\omega L} = \frac{1}{\omega L}\angle -90^o \qquad \omega = 2\pi f$$

$$\overline{Y} = \overline{Y}_1 + \overline{Y}_2 + \overline{Y}_3 + ... \qquad \phi = \angle\overline{Y} = \angle\overline{V}_S = \tan^{-1}\frac{B_{tot}}{G_{tot}}$$

AC Power:

$$S = V_S I = I^2 Z \qquad P = V_S I\cos\phi = I^2 R \qquad Q = V_S I\sin\phi = I^2 X \qquad \cos\phi = \frac{P}{S}$$

Diodes:
Forward voltage drop is 0.7 V for silicon diode and 0.3 V for germanium diode

Zener impedance $$Z_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

Half-Wave Rectifier:

$$V_{out(p)} = V_{\sec(p)} - 0.7V \qquad V_{AVG} = \frac{V_{out(p)}}{\pi} \qquad PIV = V_{\sec(p)}$$

Centre-Tapped Full-Wave Rectifier:

$$V_{out(p)} = \frac{V_{\sec(p)}}{2} - 0.7V \qquad V_{AVG} = \frac{2V_{out(p)}}{\pi} \qquad PIV = 2V_{out(p)} + 0.7V$$

Full-Wave Bridge Rectifier:

$$V_{out(p)} = V_{\sec(p)} - 1.4\ V \quad V_{AVG} = \frac{2V_{out(p)}}{\pi} \qquad PIV = V_{out(p)} + 0.7\ V$$

Ripple Factor:

$$r = \frac{V_{r(rms)}}{V_{DC}} \text{ where } V_{r(rms)} = \frac{V_{r(p-p)}}{2\sqrt{3}}$$

Line Regulation = $\left(\frac{\Delta V_{OUT}}{\Delta V_{IN}}\right)100\%$ **Load Regulation =** $\left(\frac{V_{NL} - V_{FL}}{V_{FL}}\right)100\%$

Transistors:

$$I_E = I_C + I_B \qquad \beta_{DC} = \frac{I_C}{I_B} \qquad \alpha_{DC} = \frac{I_C}{I_E} \qquad \beta_{DC} = \frac{\alpha_{DC}}{1-\alpha_{DC}}$$

$$V_{BE} = 0.7V \qquad V_{CC} = V_{CE} + I_C R_C$$

$$V_{BB} = V_{BE} + I_B R_B \qquad V_{CE} = V_{CB} + V_{BE}$$

Operational Amplifiers

Voltage Gain of Inverting Amplifier: $-\frac{R_f}{R_i}$

Voltage Gain of Non-inverting Amplifier: $1 + \frac{R_f}{R_i}$

Output voltage of summing amplifier:

$$V_O = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3 + \ldots\ldots\ldots\ldots + \frac{R_f}{R_n}V_n\right) \text{ for “n” inputs}$$

Threshold Voltages for comparator with positive feedback:

Upper Trigger Point (UTP) = $\frac{R_2}{R_1 + R_2}(+V_{O[max]})$

Lower Trigger Point (LTP) = $\frac{R_2}{R_1 + R_2}(-V_{O[max]})$