2018/2019 SEMESTER TWO EXAMINATION

Diploma in Aerospace Electronics (DASE) 1st Year FT
Diploma in Computer Engineering (DCPE) 1st Year FT
Diploma in Electrical & Electronic Engineering (DEEE) 1st Year FT
Diploma in Engineering Systems (DES) 1st Year FT
Diploma in Energy Systems and Management (DESM) 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. Which one of the following statements is not true for a P-type semiconductor?

(a) It is doped with a trivalent impurity.
(b) Holes are the majority carriers.
(c) It is positively charged.
(d) Electrons are the minority carriers.

A2. The purpose of adding pentavalent impurity to silicon is to

(a) increase the number of free electrons.
(b) increase the number of holes.
(c) reduce the number of holes.
(d) reduce the number of free electrons.

A3. The average value of a full-wave rectified voltage with a peak output voltage of 35 V is

(a) 11.14 V
(b) 17.5 V
(c) 22.28 V
(d) 70 V

A4. Which one of the following IC voltage regulators gives a DC output voltage of +24 V?

(a) 7812
(b) 7824
(c) 7912
(d) 7924

A5. A Zener diode has an impedance of 7 Ω and a maximum voltage of 6.85 V at a maximum current of 75 mA. If the Zener diode is operating at a current of 35 mA, its operating voltage is equal to

(a) 6.150 V
(b) 6.325 V
(c) 6.570 V
(d) 6.605 V

A6. For the circuit shown in Figure A6 assuming that the 4 LEDs are identical, the voltage drop across each LED is equal to

(a) 4 V
(b) 3.92 V
(c) 2.98 V
(d) 1.96 V

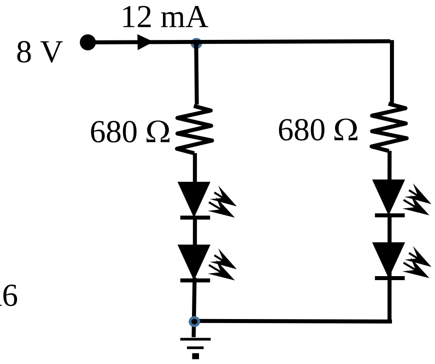


Figure A6

A7. Assuming that the transistor shown in Figure A7 is biased in the active region with V_{CE} = 2.5 V, the collector current I_C is equal to

(a) 0.11 mA
(b) 9.26 mA
(c) 22.22 mA
(d) 27.78 mA

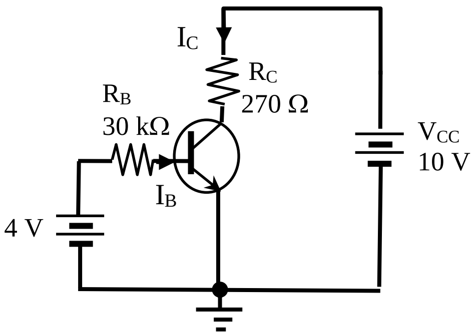


Figure A7

A8. For the transistor circuit shown in Figure A7, the base current I_B is equal to

(a) 0.11 mA
(b) 0.133 mA
(c) 0.167 mA
(d) 0.177 mA

A9. An averaging amplifier has 5 inputs. The ratio of the resistors, R_f/R_i is equal to

(a) 0.2
(b) 0.4
(c) 5
(d) 10

A10. For the operational amplifier circuit shown in Figure A10, the output voltage,V_o is equal to

(a) 4 $V_{(p)}$
(b) -4 $V_{(p)}$
(c) 5 $V_{(p)}$
(d) -5 $V_{(p)}$

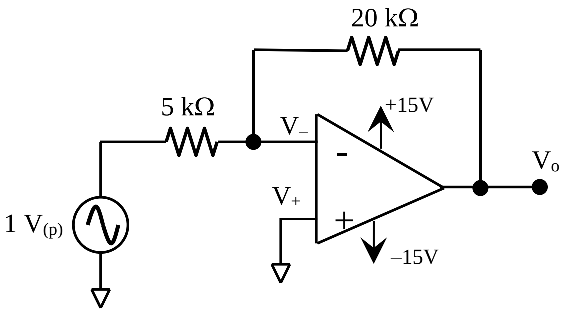


Figure A10

SECTION B

SHORT QUESTIONS (80 marks)

B1. For the circuit shown in Figure B1,

(a) name the circuit and explain how it works. (6 marks)

(b) Vcc = 12 V, coil resistance of relay = 1 kΩ, $V_{CE(sat)}$ = 0.2 V and β_{DC} = 220 find the minimum base current, I_B to saturate the transistor. (4 marks)

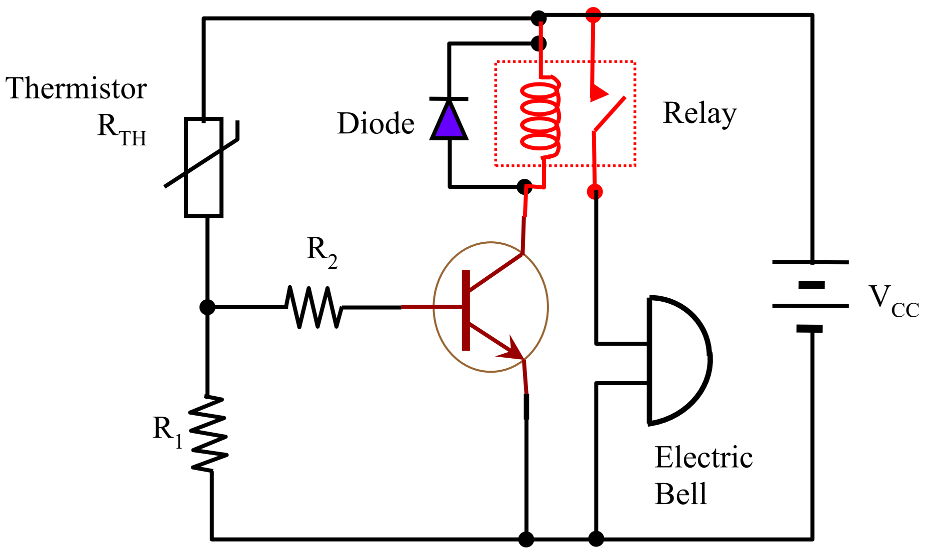


Figure B1

B2. For the circuit shown in Figure B2,

(a) sketch the output voltage waveform across diode D_1. (5 marks)

(b) sketch the output voltage waveform across the resistor R_L. (5 marks)

Indicate the maximum and minimum values of the waveforms. The circuit uses silicon diodes.

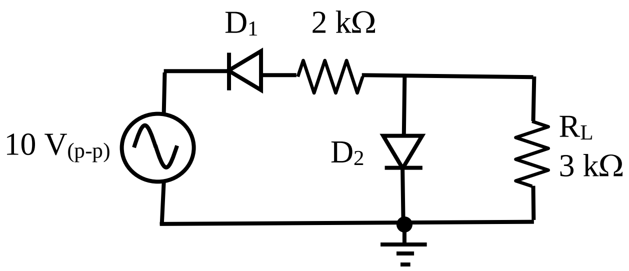


Figure B2

B3. For the circuit shown in Figure B3 if V_{in1} = 0.4 V and V_{in2} = 0.6 V,

(a) calculate the output voltage V_{out1}; (3 marks)

(b) calculate the output voltage V_{out2}; (4 marks)

(c) draw a circuit to be connected to V_{out2} such that its output is inverted. (3 marks)

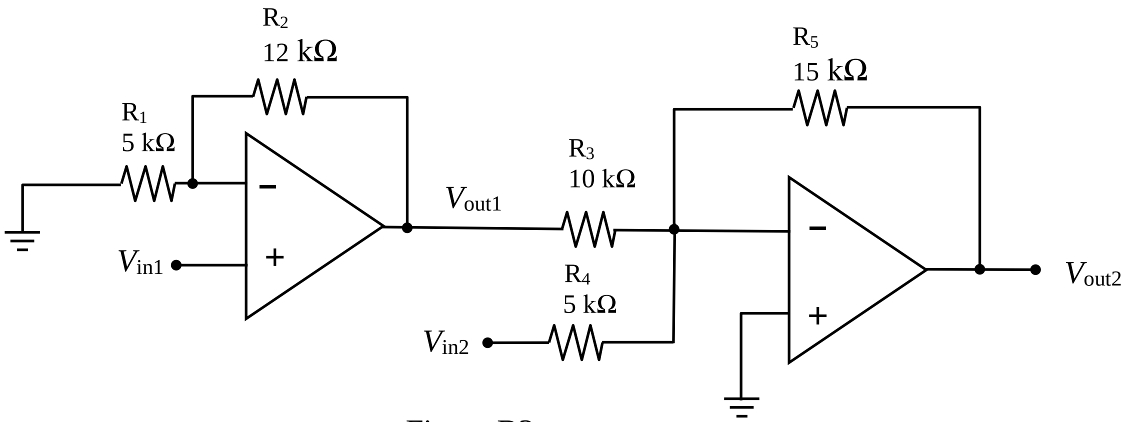


Figure B3

B4. For the circuit shown in Figure B4,

(a) calculate the reference voltage V_{ref1} and V_{ref2}; (4 marks)

(b) determine the output voltage V_{out1} and V_{out2}; (4 marks)

(c) state whether LED1 and LED2 are "ON" or "OFF". (2 marks)

Assume $+V_{sat}$ = 13 V and $-V_{sat}$ = -13 V

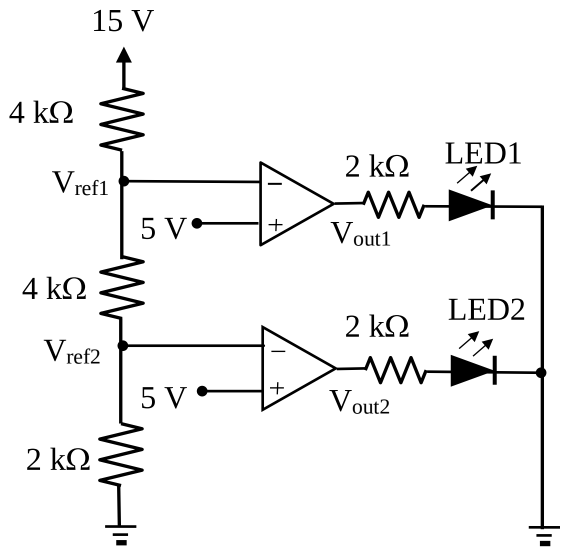


Figure B4

B5. For the circuit shown in Figure B5,

(a) find the total voltage V_T in polar form; (3 marks)

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

(c) write down the time-domain expression for I; (2 marks)

(d) draw the phasor diagram for V_1, V_2, and V_3. (3 marks)

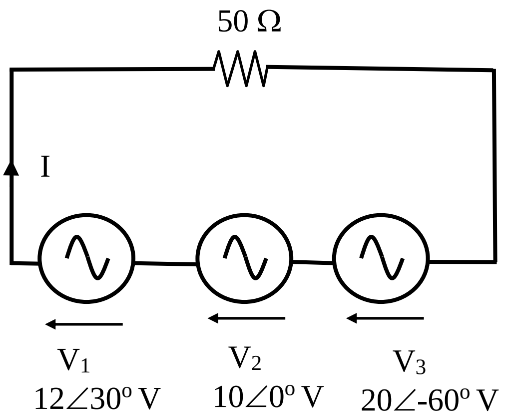


Figure B5

B6. For the circuit shown in Figure B6, calculate

(a) the total impedance Z in polar form; (4 marks)

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

(c) the total reactive power; (2 marks)

(d) the voltage across the capacitor in polar form. (2 marks)

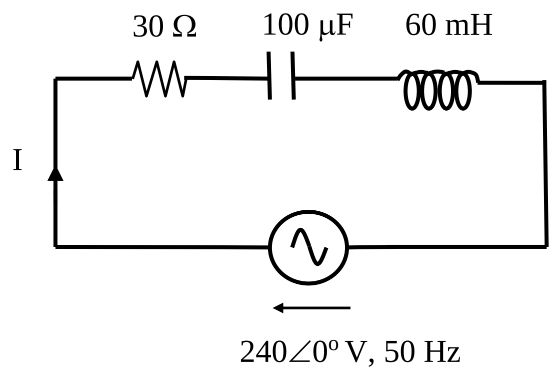


Figure B6

B7. For the circuit shown in Figure B7 if the total power of the circuit is 300 W and the power factor is 0.85 lagging, calculate

(a) the current I in polar form; (4 marks)

(b) the total impedance in polar form; (2 marks)

(c) the resistance R; (2 marks)

(d) the inductance L. (2 marks)

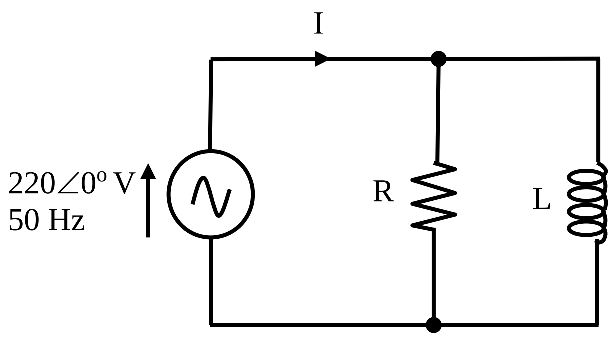


Figure B7

B8. For the circuit shown in Figure B8, calculate

(a) the currents I_R, I_C, I_L and I_T in polar form: (8 marks)

(b) the total admittance Y_T in polar form. (2 marks)

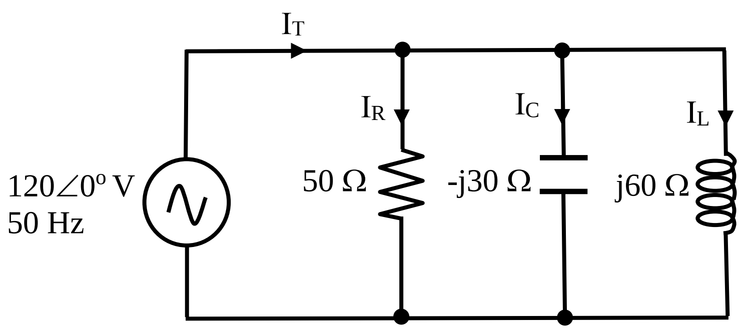


Figure B8

- 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, $X_C = \dfrac{1}{2\pi f C}$ in ohms

Inductors:

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

AC Voltages and Currents:

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

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

AC Impedance/Admittance:

Series circuit,

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

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

Parallel circuit,

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

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

AC Power:1

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

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:

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

Centre-Tapped Full-Wave Rectifier:

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

Full-Wave Bridge Rectifier:

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

Ripple Factor:

$r = \frac{V_{r(rms)}}{V_{DC}}$ 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:

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

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

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

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:

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

Threshold Voltages for comparator with positive feedback:

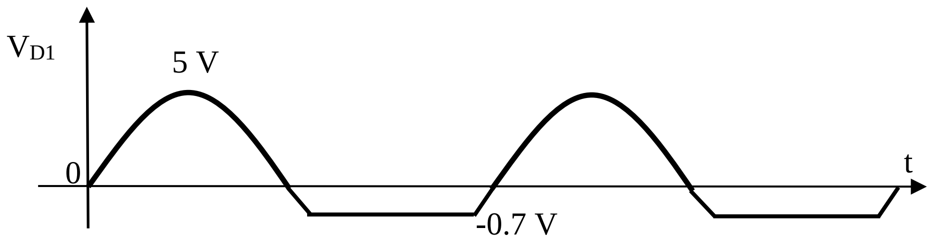
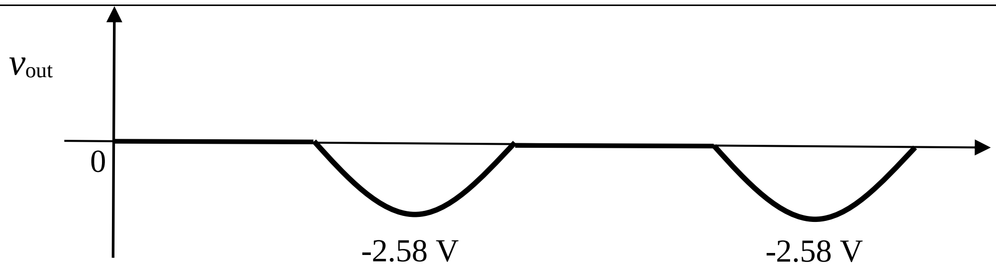
Upper Trigger Point (UTP) = $\frac{R_2}{R_1 + R_2}(+V_{O[max]})$

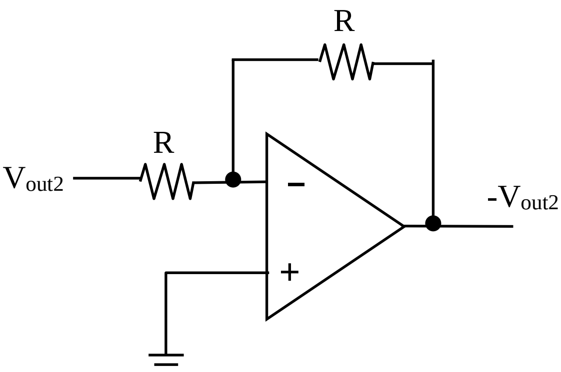
Lower Trigger Point (LTP) = $\frac{R_2}{R_1 + R_2}(-V_{O[max]})$

ANSWERS

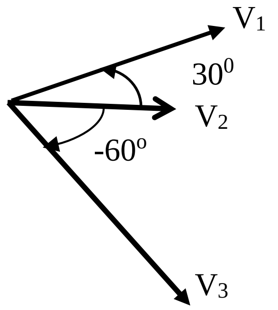
A1	**c**			A6	**d**
A2	**a**			A7	**d**
A3	**c**			A8	**a**
A4	**b**			A9	**a**
A5	**c**			A10	**b**

B1 (a)	Automatic fire alarm circuit Please refer to the textbook.
(b)	$I_{B(min)}$= 53.64 μA

B2 (a)	
(b)	

B3 (a)	V_{out1} = 1.36 V
(b) (c)	V_{out2} = -3.84 V 

B4 (a)	$V_{ref1} = 9$ V $V_{ref2} = 3$ V
(b)	$V_{out1} = -V_{sat} = -13$ V ($V_{ref1} > 5$ V) $V_{out2} = +V_{sat} = 13$ V ($V_{ref2} < 5$ V)
(c)	LED1 will be "OFF" since it is reverse biased. LED2 will be "ON" since it is forward biased.

B5 (a)	$\overline{V}_T = 32.43\angle{-20.43^o}$ V
(b)	$I = 0.65\angle -20.43° \ A$
(c)	$i(t) = 0.919\sin(\omega t - 20.43^o)$ A
(d)	

B6 (a)	$Z = 32.68\angle{-23.35^o}\ \Omega$
(b)	$I = 7.34\angle 23.35°$ A
(c)	Q = 698.2 VAR
(d)	$V_C = 233.41\angle{-66.65^o}$ V

B7 (a)	$I = 1.6\angle{-31.79^o}$ A
(b)	$Z = 137.5\angle 31.79°\ \Omega$
(c)	R = 161.81 Ω
(d)	L = 0.831 H

B8 (a)	$I_R = 2.4\angle 0° \ A$; $I_C = 4\angle 90° \ A$; $I_L = 2\angle -90° \ A$; $I_T = 124\angle 39.8° \ A$
(b)	$Y = 0.026\angle 39.8° \ S$