2017/2018 SEMESTER TWO 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. Which one of the following processes is a doping process?

(a) Aluminium is added to intrinsic semiconductor.
(b) Thermal energy is applied to intrinsic semiconductor.
(c) A dc supply is connected to intrinsic semiconductor.
(d) A p-type semiconductor is joined to an n-type semiconductor.

A2. The category of material that exhibits the largest energy gap between its valence band and its conduction band is classified as

(a) conductor.
(b) insulator.
(c) semiconductor.
(d) extrinsic semiconductor.

A3. If the load resistance of a capacitor-filtered full-wave rectifier is reduced, the ripple voltage

(a) has a different frequency.
(b) is not affected.
(c) decreases.
(d) increases.

A4. Which one of the following devices is often used as a transducer in an automatic fire alarm circuit?

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

A5. The device symbol shown in Figure A5 represents

(a) a variable capacitor.
(b) a Zener diode.
(c) a photo diode.
(d) a light dependent resistor.

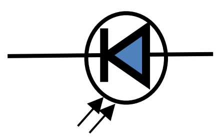

Figure A5

1 kΩ

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

(a) 2.12 mA
(b) 2.4 mA
(c) 4.6 mA
(d) 4.83 mA

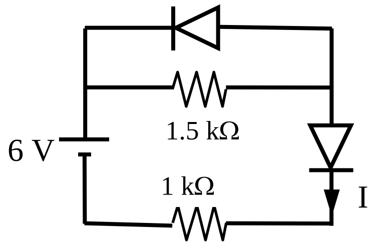

Figure A6

A7. The transistor in Figure A7 is biased in the active region if V_{CE} = 2 V, the collector current I_C is equal to

(a) 0.087 mA
(b) 0.133 mA
(c) 15 mA
(d) 19.12 mA

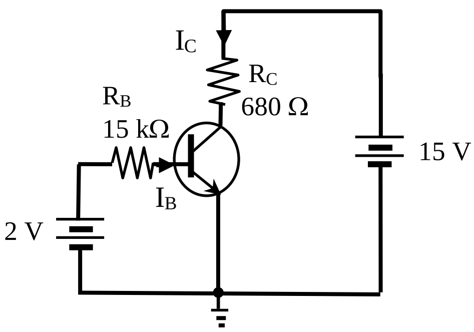

Figure A7

A8. For the transistor circuit shown in Figure A7, β_{DC} is equal to

(a) 442
(b) 221
(c) 1.005
(d) 0.995

A9. The Zener regulator circuit shown in Figure A9 operates at a Zener voltage of 3.1 V. The current I is equal to

(a) 3.1 mA
(b) 5 mA
(c) 14.5 mA
(d) 30 mA

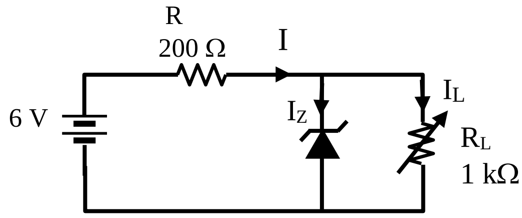

Figure A9

A10. The circuit shown in Figure A10 uses a silicon diode. During the positive half cycle of the supply voltage, the peak value of current I is equal to

(a) 1.15 mA
(b) 3 mA
(c) 4.6 mA
(d) 6 mA

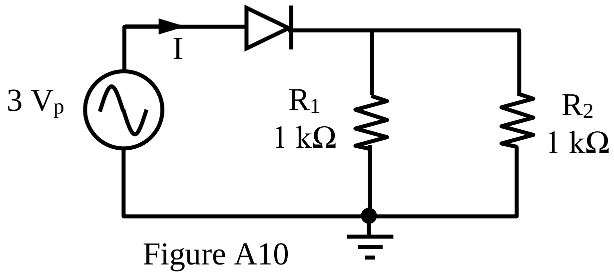

Figure A10

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) if Vcc = 15 V, Rc = 330 Ω, $V_{CE(sat)}$ = 0.2 V, β_{DC} = 180 and the forward bias voltage V_{LED} = 1.85 V, find the minimum base current to saturate the transistor. (4 marks)

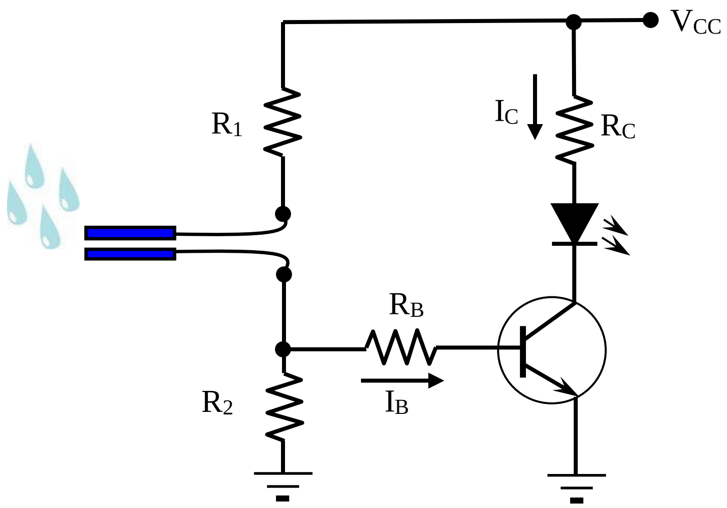

Figure B1

B2. (a) The output of a dc power supply after rectification and filtering is almost a constant DC voltage with a small ripple riding on it. Name a device that can be used to obtain a “perfect” DC output. (2 marks)

(b) For the circuit shown in Figure B2,

(i) sketch the voltage waveform V_D across the silicon diode. Indicate the maximum and the minimum values of the waveform; (4 marks)

(ii) sketch the voltage waveform across the resistor R_1. Indicate the maximum and the minimum values of the waveform. (4 marks)

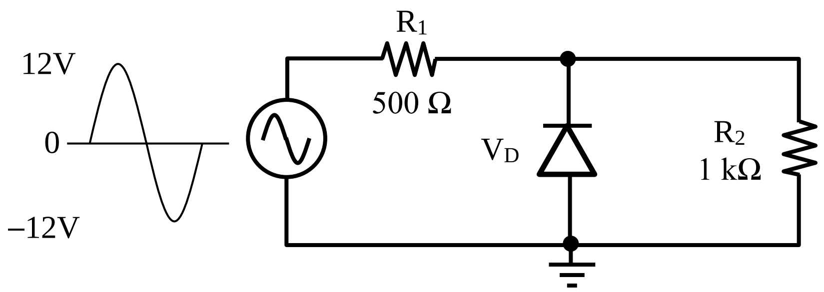

Figure B2

B3. For the circuit shown in Figure B3,

(a) calculate the output voltage V_{out}; (4 marks)

(b) draw a circuit to be connected to V_{out} such that its output is equal to $-4V_{out}$; (3 marks)

(c) calculate the resistance of an additional resistor be connected with R_1 so that $V_{out} = -2.2$ V. (3 marks)

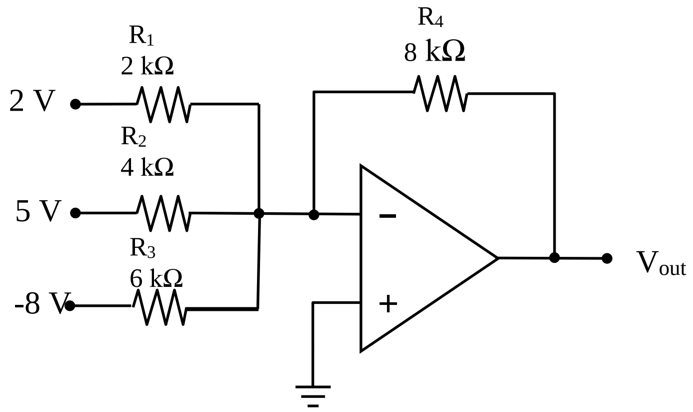

Figure B3

B4. (a) State 4 characteristics of a practical operational amplifier. (4 marks)

(b) For the circuit shown in Figure B4, determine

(i) V_{UTP} and V_{LTP}; (4 marks)

(ii) the value of V_{out} when V_{in} is larger than V_{UTP}; (1 mark)

(iii) the value of V_{out} when V_{in} is smaller than V_{LTP} (1 mark)

Assume that the saturation voltages of the operational amplifier are

$+V_{sat} = 12$ V and $-V_{sat} = -12$ V

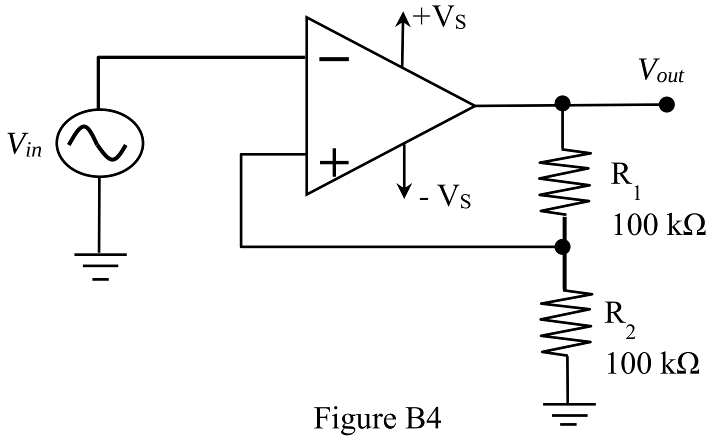

Figure B4

B5. The phasor diagram for 3 sinusoidal voltage sources (A, B & C) in rms values is shown in Figure B5.

(a) Express the 3 ac voltage phasors in polar form. (3 marks)

(b) Write down the sinusoidal equations for the 3 voltage sources. (3 marks)

(c) Express the sum of phasor A and phasor B in rectangular form. (2 marks)

(d) State the phase relationship between phasor A and phasor C. (2 marks)

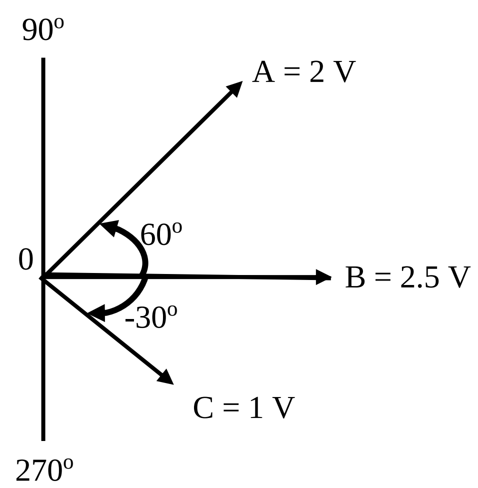

Figure B5

B6. For the circuit shown in Figure B6, if the reactive power of the circuit is 250 VAR and the current I is $3\angle -\phi^{o}$ A, calculate

(a) the angle ϕ; (3 marks)

(b) the power factor; (2 marks)

(c) the resistance R; (3 marks)

(d) the inductance L. (2 marks)

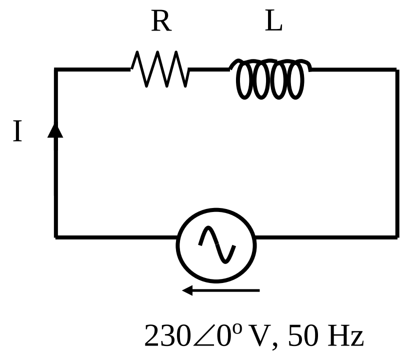

Figure B6

B7. For the circuit shown in Figure B7, calculate

(a) the total admittance in polar form; (3 marks)
(b) the total impedance in polar form; (2 marks)
(c) the total current I_T in polar form; (3 marks)
(d) the true power. (2 marks)

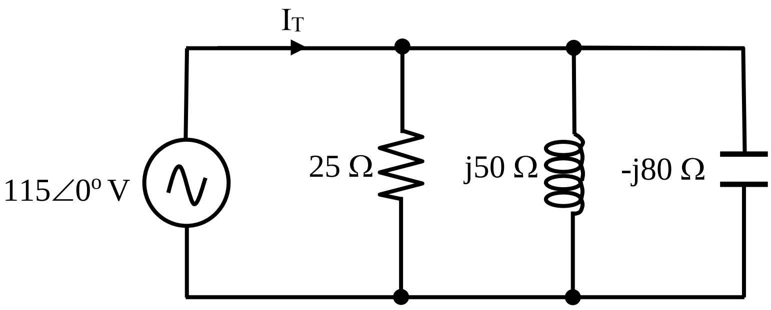

Figure B7

B8. For the circuit shown in Figure B8,

(a) calculate the total impedance Z in polar form; (3 marks)

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

(c) calculate the voltages V_R and V_C in polar form; (3 marks)

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

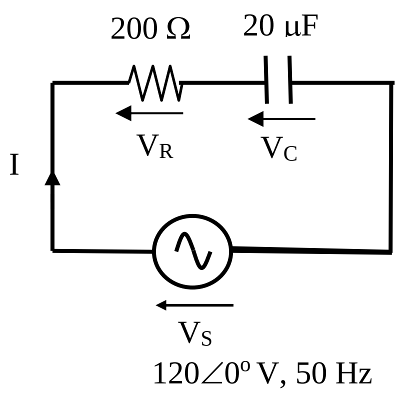

Figure B8

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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,

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

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

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:

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

Diodes:

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

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

Half-Wave Rectifier:

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

Centre-Tapped Full-Wave Rectifier:

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

Full-Wave Bridge Rectifier:

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

Ripple Factor:

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

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

Transistors:

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

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

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

Operational Amplifiers

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

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

Output voltage of summing amplifier:

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

Threshold Voltages for comparator with positive feedback:

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

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