SAS Code
MST

2016/2017 SEMESTER TWO MID-SEMESTER TEST

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: 1½ Hours

Instructions to Candidates

1. The Singapore Polytechnic Examination Rules are to be complied with.

2. This paper consists of **TWO** sections:
   Section A - 10 Multiple Choice Questions, 3 marks each.
   Section B - 5 Short Questions, 14 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 order that it was answered in the boxes found on the front cover of the answer booklet under the column “Question Answered”.

6. This paper consists of 7 pages (inclusive of the cover page and the formulae sheet).

SECTION A

MULTIPLE CHOICE QUESTIONS [3 marks each]

1. Please **tick** your answers in the **MCQ box** on the second page of the answer booklet.
2. No marks will be deducted for incorrect answers.

A1. For a current to flow in a silicon diode, a voltage of at least 0.7 V must be applied across it. This voltage is to

(a) generate electron-hole pairs in the diode.

(b) overcome the potential barrier in the diode.

(c) overcome the resistance in the diode.

(d) widen the potential barrier in the diode.

A2. The purpose of adding impurities to intrinsic semiconductor materials is to

(a) reduce the number of electron-hole pairs in the material.

(b) increase the number of electron-hole pairs in the material.

(c) reduce the number of majority carriers in the material.

(d) increase the number of majority carriers in the material.

A3. The circuit shown in Figure A3 uses a silicon diode. During the negative half cycle of the supply voltage, the peak current, I is

(a) 0 mA

(b) 1.4 mA

(c) 2.0 mA

(d) 3.1 mA

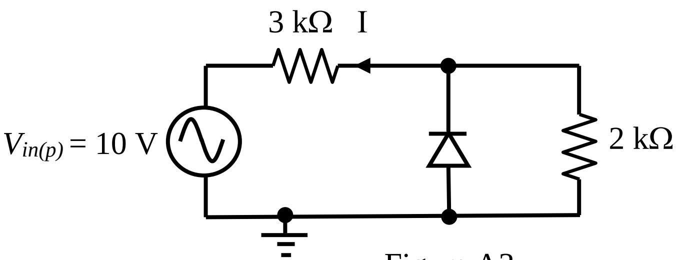


Figure A3

A4. Which one of the following devices is operated in the reverse biased characteristics for its application?

(a) Relay
(b) Zener diode
(c) PN junction diode
(d) Light emitting diode

A5. The circuit shown in Figure A5 uses silicon diodes. The current, I flowing in the diode is

(a) 2.20 mA

(b) 2.43 mA

(c) 2.67 mA

(d) 3.30 mA

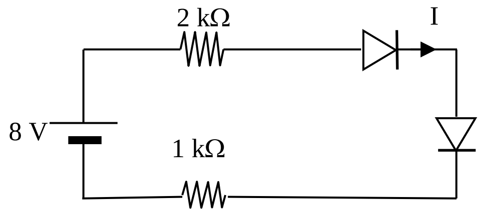


Figure A5

A6. Which one of the following sequences can be a correct order of a DC power supply?

(a) Step-up transformer, filter, rectifier and voltage regulator
(b) Step-up transformer, voltage regulator, filter and rectifier
(c) Step-down transformer, rectifier, filter and voltage regulator
(d) Step-down transformer, filter, rectifier and voltage regulator

A7. Which one of the following IC voltage regulators gives a DC output voltage of 24 V?

(a) 7918
(b) 7924
(c) 7818
(d) 7824

A8. In a PNP transistor which of the following layers have holes as the majority carrier?

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

A9. The collector current of a NPN transistor is approximately proportional to the base current when it is operating in the ______ region.

(a) saturation
(b) avalanche breakdown
(c) active
(d) cut-off

A10. Which one of the following devices is NOT a transducer?

(a) Photodiode
(b) Zener diode
(c) Moisture sensor
(d) Light dependent resistor

SECTION B (14 marks each)

B1. (a) Explain the process of doping in producing n-type semiconductors.

[2 marks]

(b) For the circuit shown in Figure B1,

(i) state with reason whether the LED is reverse-biased or forward biased. [2 marks]

(ii) calculate the currents flowing through resistors R_1 and R_2. Indicate the direction of both currents. [9 marks]

(iii) calculate the current flowing through the LED. [1 mark]

Assume the LED used in the circuit has a forward voltage drop of 1.9 V.

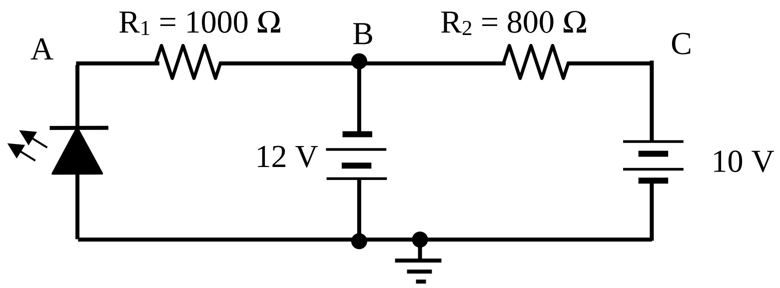


Figure B1

B2. The circuit shown in Figure B2 is a Zener diode regulator circuit. Given V_{ZT} = 6.1 V at I_{ZT} = 55 mA; Z_Z = 10 Ω; and V_{ZM} = 6.7 V.

(a) Find I_{ZM} of the Zener diode. [5 marks]

(b) If I_{ZM} flows through the Zener diode, determine:

(i) the current, I flowing through the 15 Ω resistor. [3 marks]

(ii) the current, I_L flowing through the variable resistor R_L. [3 marks]

(c) Choose a suitable power rating of resistor R_L from the following list: 0.25W, 0.5W, 1W, and 2W. [3 marks]

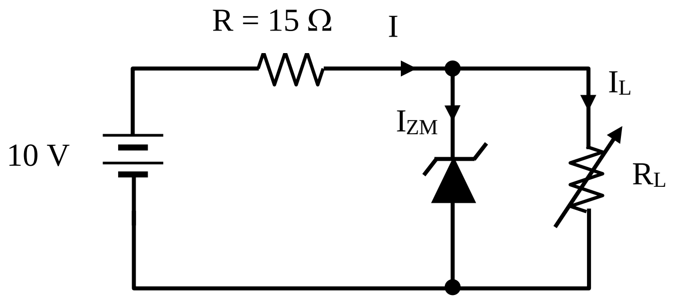


Figure B2

B3. For the circuit shown in Figure B3,

(a) state the type of rectifier circuit shown. [2 marks]

(b) calculate the peak voltage across the load resistor, R_L. [3 marks]

(c) calculate the average current flowing through each diode. [4 marks]

(d) calculate the PIV for each diode. [3 marks]

(e) sketch the voltage waveform across the load resistor, R_L. [2 marks]

Assume the diodes used are silicon diodes.

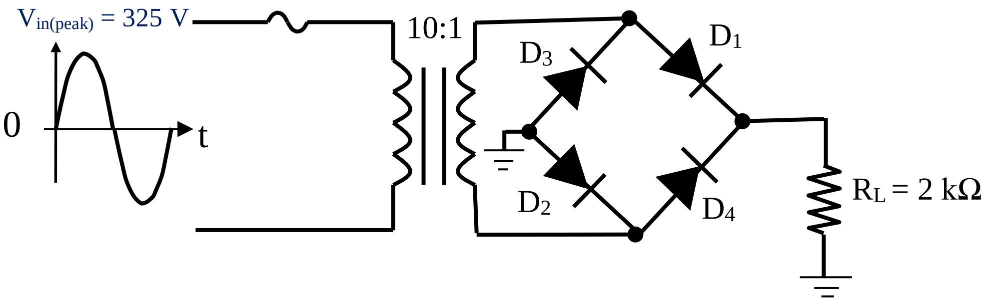


Figure B3

B4. For the transistor circuit shown in Figure B4 if the voltage across R_C is 3V, calculate

(a) the emitter current, I_E [6 marks]

(b) the voltage across the transistor, V_{CE} [2 marks]

(c) the current gains, β_{DC} and α_{DC} [4 marks]

(d) the saturation current $I_{C(sat)}$ taking $V_{CE(sat)}$ = 0.2 V [2 marks]

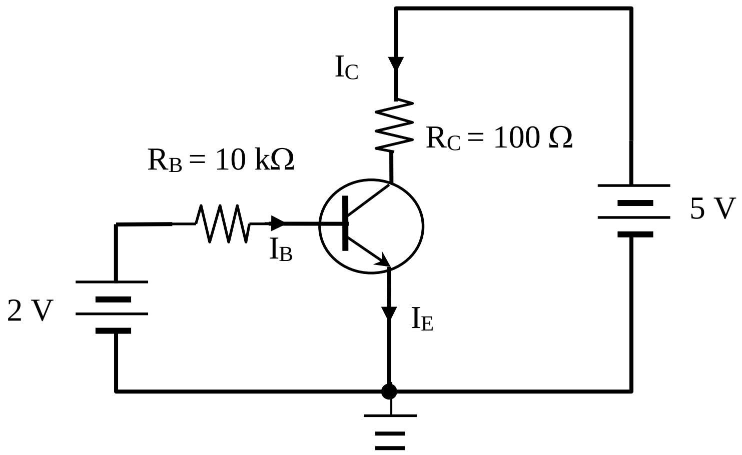


Figure B4

B5. The moisture sensor circuit shown in Figure B5 is used to detect rain drops. The LED will light up when the sensor gets wet. The circuit has the following parameters:

Resistance of the moisture sensor when it is wet, $R_{M(wet)} = 0\ \Omega$ (close-circuited)
Resistance of the moisture sensor when it is dry, $R_{M(dry)} = \infty\ \Omega$ (open-circuited)
$V_{LED} = 2.1$ V when it is forward biased and conducting
The current gain of the transistor, $\beta_{DC} = 180$ and $V_{CE(sat)} = 0.2$V

(a) What is the voltage across R_2 when the moisture sensor is dry? [2 marks]

(b) When the moisture sensor is wet, calculate

(i) the voltage across R_2. [4 marks]

(ii) the base current, I_B. [2 marks]

(iii) the saturated collector current, $I_{C(sat)}$. [3 marks]

(c) State with reason whether the transistor is operating in the saturation or active region. [3 marks]

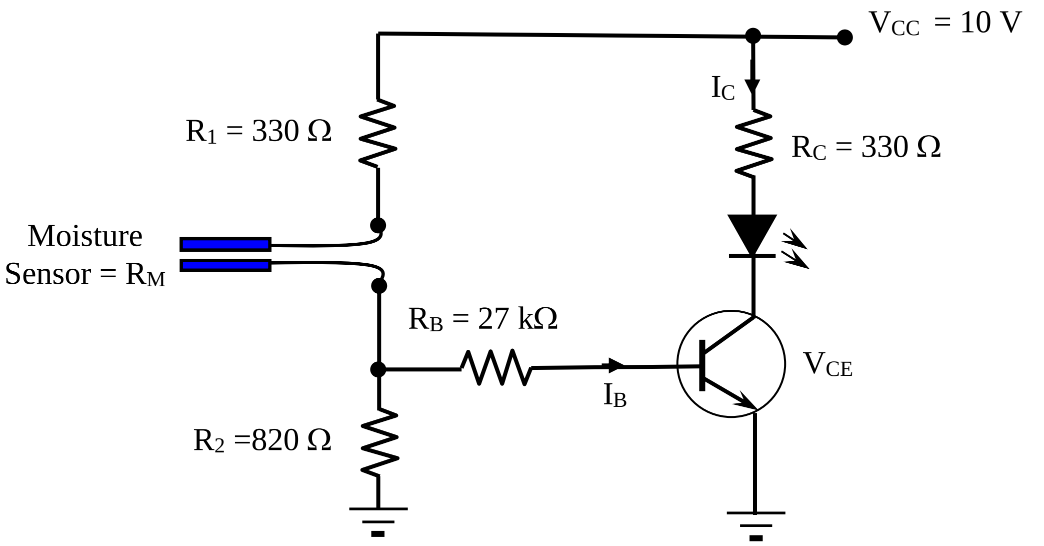


Figure B5

- End of Paper –

Formulae

Energy, Work Done, Charge, Power:

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

Number of electrons in a shell (band) = $2N^2$

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

Diodes:

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

Zener dynamic resistance $Z_Z = \dfrac{\Delta V_Z}{\Delta I_Z}$

AC Voltages and Currents:

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

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

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:

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

Ripple Factor:

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

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

Transistors:

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

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

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

Answers:

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
B	D	D	B	A	C	D	C	C	B

B1(a)

To produce n-type semiconductors pentavalent impurities are added to pure semiconductor materials. This will result in more free electrons.

B1(b)(i)

$V_A = V_B = -12$ V

Since V_A is less than -1.9V the LED will be forward biased.

B1(b)(ii) I_{AB}= 10.1 mA I_{CB}= 27.5 mA

B1(b)(iii) I_{LED}= 10.1 mA

B2(a) I_{ZM}= 115 mA

B2(b)(i) I = 220 mA

B2(b)(ii) I_L = 105 mA

B2(c) P = 0.7035 W choose 1 W resistor

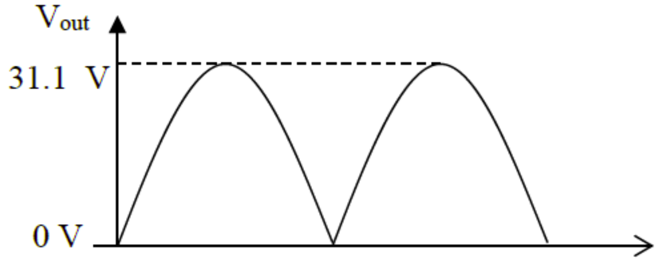
B3(a) Full wave bridge rectifier

B3(b) $V_{out(p)}$= 31.1 V

B3(c) I_{avg} in each diode = 4.95 mA

B3(d) PIV = 31.8 V

B3(e)



B4(a) I_E = 30.13 mA

B4(b) V_{CE} = 2 V

B4(c) β_{DC}= 230.8 α_{DC}= 0.996 **B4(d)** $I_{C(sat)}$ = 48 mA

B5(a) $V_{R2} = 0$

B5(b)(i) $V_{R2} = 7.13$ V

B5(b)(ii) $I_B = 0.238$ mA

B5(b)(iii) $I_{C(sat)} = 23.33$ mAc)

B5(c) Transistor is operating in the saturation mode any of the following reasons
since I_B is more than $I_{B(min)}$ or
since I_C is greater than $I_{C(sat)}$ or
since V_{CE} is less than $V_{CE(sat)}$