SAS Code
MST

2018/2019 SEMESTER TWO MID-SEMESTER TEST

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)
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 (PEEE 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. Electrons in a P-type semiconductor are

(a) majority carriers that are produced by doping.
(b) majority carriers that are thermally produced.
(c) minority carriers that are thermally produced.
(d) minority carriers that are produced by doping.

A2. The reverse current in a photodiode

(a) does not change with light intensity.
(b) changes its direction with light intensity.
(c) decreases with increase in light intensity.
(d) increases with increase in light intensity.

A3. The average value of a half-wave rectified voltage with a peak output voltage of 30 V is equal to

(a) 9.55 V
(b) 19.1 V
(c) 29.3 V
(d) 94.25 V

A4. The circuit shown in Figure A4 uses silicon diodes. The value of current I is equal to

(a) 4 mA
(b) 3.77 mA
(c) 2 mA
(d) 1.88 mA

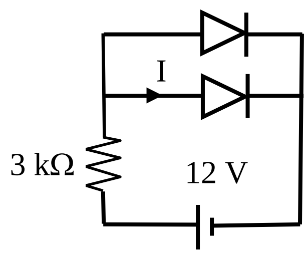


Figure A4

A5. The collector current of a NPN transistor is approximately proportional to the base current when it is operating in the

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

A6. Which one of the following devices is often used as a transducer in an automatic lighting circuit?

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

A7. Which one of the following devices is used as a transducer in the design of an automatic plant watering system?

(a) Thermistor.
(b) Moisture sensor.
(c) Photodiode.
(d) Zener diode.

A8. Which one of the following statements best describes the purpose of the relay coil shown in Figure A8?

(a) To function as an electronic switch.
(b) To amplify the voltage across the relay coil.
(c) To eliminate the use of collector resistor.
(d) To activate the relay contact.

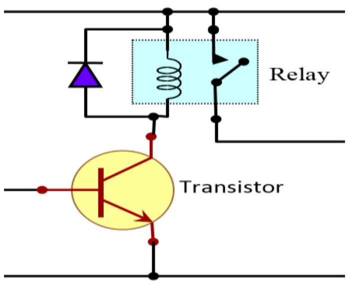


Figure A8

A9. The purpose of the diode in Figure A8 is

(a) to allow current to flow through the transistor.
(b) to close the relay contact.
(c) to protect the transistor from damage.
(d) to protect the relay coil from damage.

A10. The thermistor is a suitable transducer to be use in the design of

(a) an air conditioning system.
(b) an automatic clothes drying rack.
(c) an automatic wind screen wiper.
(d) an automatic sun tracker.

Answers for MCQ

1) c **2) d** **3) a** **4) d** **5) b**

6) c **7) b** **8) d** **9) c** **10) a**

SECTION B (14 marks each)

B1. (a) Explain the process of doping to produce N-type and P-type semiconductors. [4 marks]

(b) For the circuit shown in Figure B1,

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

(ii) calculate the currents flowing through the resistors R_1, R_2 and R_3. Indicate the directions of all currents. [7 marks]

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

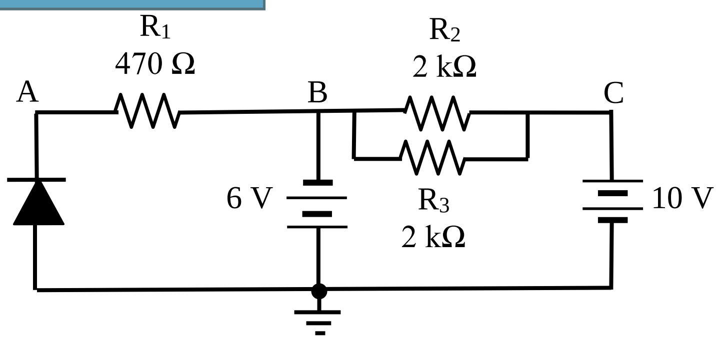
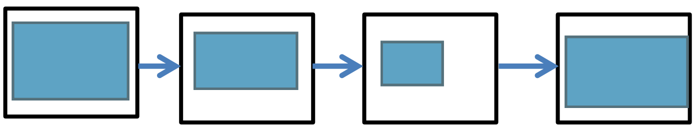


Figure B1

B2. (a) Draw the block diagram of a basic DC power supply and explain the function of each component of the block diagram. [8 marks]



(b) For the circuit shown in Figure B2-A, sketch the output voltage waveform across the resistor R_2 indicating the minimum and maximum values. The circuit uses a silicon diode. [6 marks]

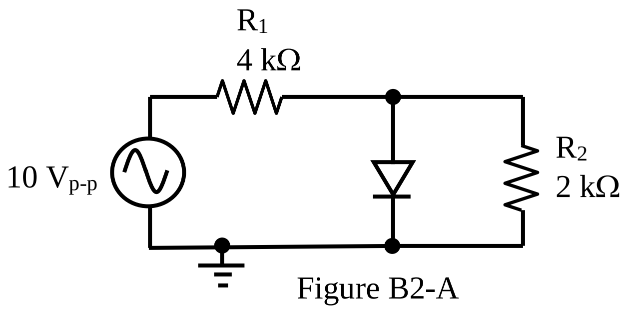


Figure B2-A

B3. For the circuit shown in Figure B3,

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

(b) calculate the peak current through each diode. [2 marks]

(c) calculate the peak voltage across each half of the secondary winding. [3 marks]

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

(e) calculate the turn ratio of the transformer. [4 marks]

Assume that the diodes used are silicon diodes.

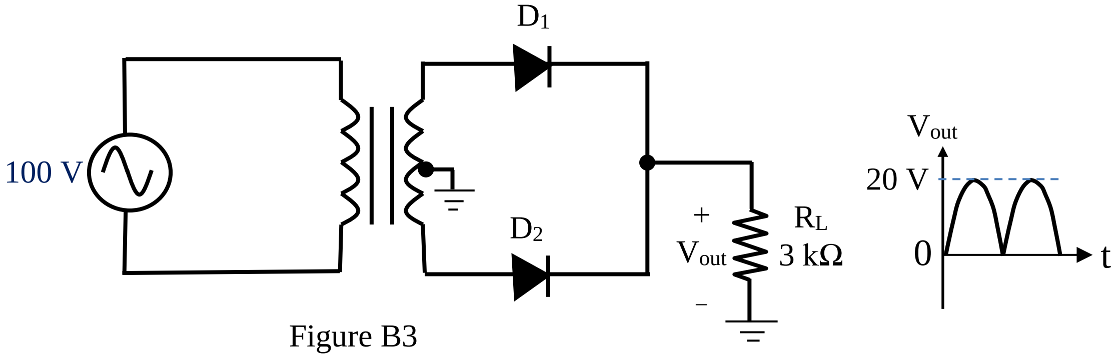


Figure B3

B4. (a) For the circuit shown in Figure B4-A, calculate the value of R_L if $V_Z = 6.7$ V at $I_Z = 32$ mA. [9 marks]

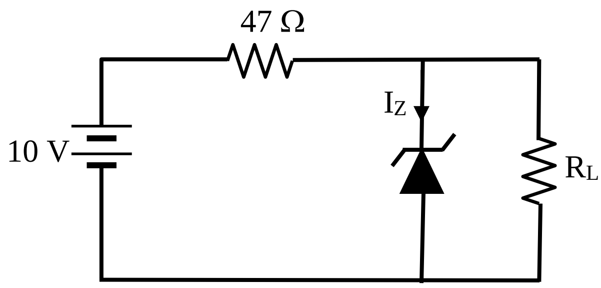


Figure B4-A

(b) For the circuit shown in Figure B4-B, calculate the supply current. Assume that the LED used in the circuit has a forward voltage drop of 1.9 V.

[5 marks]

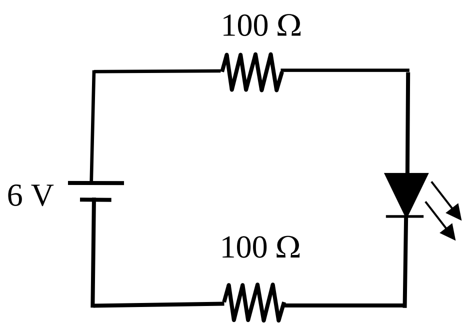


Figure B4-B

B5. For the circuit shown in Figure B5, the transistor is biased in the active region. Given that the current gain α_{DC} is 0.995, calculate

(a) the current gain, β_{DC}; [2 marks]

(b) the base current, I_B; [3 marks]

[redacted]

(c) the collector current, I_C; [2 marks]

[redacted]

(d) the emitter current, I_E; [2 marks]

[redacted]

(e) the voltage across the transistor, V_{CE}; [3 marks]

[redacted]

(f) the voltage across the transistor, V_{CE} when a forward biased LED is connected in series with R_C. Assume that the LED forward voltage V_{LED} = 1.4 V.

[redacted] [2 marks]

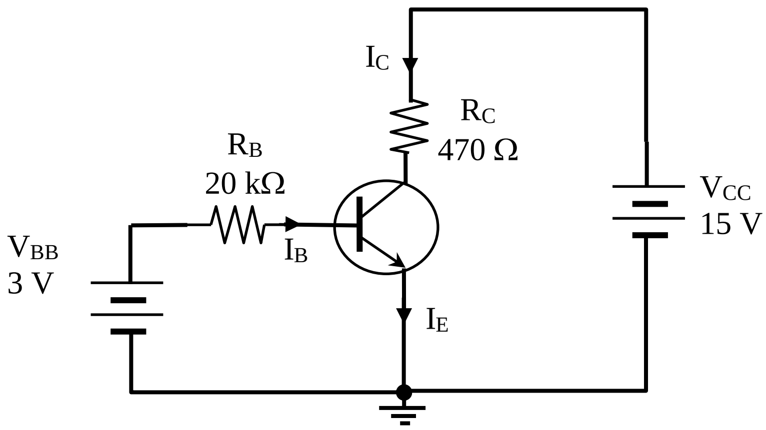


Figure B5

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Formulae

Energy, Work Done, Charge, Power:

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

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

6.25 x 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:

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

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

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

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

Transistors:

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

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

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