SAS Code
MST

2015/2016 SEMESTER TWO MID-SEMESTER TEST

Diploma in Aerospace Electronics (DASE)
Diploma in Energy Systems Management (DESM)
Diploma in Computer Engineering (DCPE)
Diploma in Electrical & Electronic Engineering (DEEE)
Common Engineering Programme (DCEP)
Diploma in Engineering with Business (DEB)
1st Year and 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 contains **7** pages, inclusive of formulae sheet.

1) a	**2) c**	**3) b**	**4) b**	**5) d**
6) c	**7) a**	**8) c**	**9) d**	**10) d**

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. Materials can be classified broadly into insulator, semiconductor and conductor base on the size of the energy gap:

(a) Between the valence band and conduction band

(b) Between the valence band and nucleus

(c) Between the conduction band and nucleus

(d) Between the electrons and holes generated thermally

A2. The conductivity of a semiconductor material can be greatly enhanced by:

(a) The recombination of its electrons and holes

(b) The thermal generation of electron-hole pairs at room temperature

(c) Doping it with impurities

(d) Shining light onto its surface

A3. Which of the following materials are not used in producing light emitting diodes?

(a) Gallium arsenide (GaAs)

(b) Silicon (Si) and germanium (Ge)

(c) Gallium arsenide phosphide (GaAsP)

(d) Gallium phosphide (GaP)

A4. The circuit shown in Figure A4 uses a silicon diode. During the negative half cycle of the supply voltage, the peak value of current I is:

(a) 1.0 mA

(b) 0.65 mA

(c) 0.35 mA

(d) 0 mA

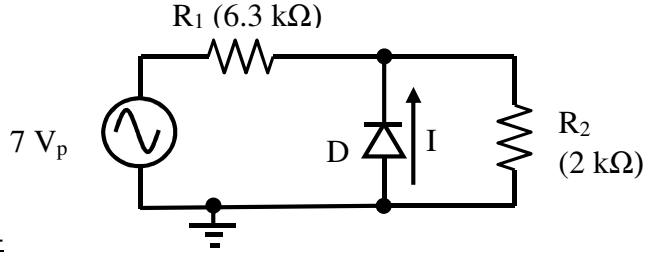

Figure A4

A5. If photodiode acts as a receiver in an automatic control circuit, the most appropriate device to be used as a transmitter is:

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

A6. Which of the following devices are reverse-biased in their normal operations?

(a) Zener diode and light-emitting diode
(b) Photodiode and light-emitting diode
(c) Zener diode and photodiode
(d) PN junction diode and light-emitting diode

A7. After a full-wave rectification of ac waveform, the voltage filter produces a dc output of 48 V with small ripple superimposed on it. If the ripple factor is 1.8%, its ripple has a peak-to-peak voltage of:

(a) 3 V (b) 300 V
(c) 6 V (d) 4.2 V

A8. In an NPN transistor, which of the following layers have electrons 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. Figure A9 shows an NPN transistor. Given that V_{BE} = 0.7 V and V_{CE} = 0.2 V, the voltage V_{BC} is:

(a) 0.9 V
(b) -0.9 V
(c) -0.5 V
(d) 0.5 V

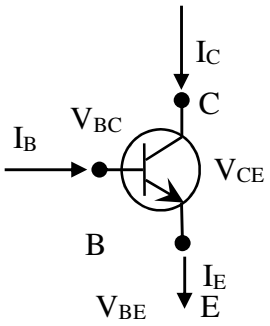

Figure A9

A10. Choose a transducer that can be used to detect rain drops and trigger the windscreen wiper of a car.

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

SECTION B (14 marks each)

B1. Figure B1 shows the output voltage waveform across a filter connected to a rectifier output.

(a) State the type of rectifier that can produce the unfiltered waveform (shown as dotted lines in Figure B1). [2 marks]

Either one of the following:
(1) Full-wave centre-tapped transformer rectifier
(2) Full-wave bridge rectifier
(3) Full-wave rectifier

(b) If the frequency of the input ac voltage is 200 Hz, what is the frequency of the unfiltered output voltage? **400 Hz** [2 marks]

(c) What component can be added to the output of the rectifier to produce the filtered waveform? **Capacitor** [2 marks]

(d) Give a reason that the rectified voltage must go through a filter before it is delivered to a DC circuit.

To reduce the large fluctuations in the output of the rectifier [2 marks]

(e) What is the ripple factor of the filtered output voltage? Express your answer in percentage form. You may assume that the average voltage (V_{dc}) is midway between the ripple peaks. 0.5773% [6 marks]

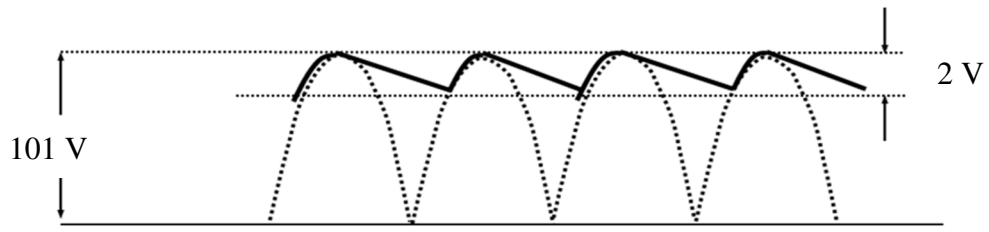

Figure B1

B2. With reference to the circuit in Figure B2:

(a) Determine whether diode D_1 is reverse-biased or forward biased with appropriate calculations. -15.4 V **forward biased** [6 marks]

(b) Determine the voltage at node B with the diode connected. **-0.7 V** [2 marks]

(c) Calculate the currents flowing through resistors R_1 and R_2. Indicate the direction of the respective currents. **91 mA** **21 mA** **70 mA** [2 marks]

Assume silicon diode is used in the circuit and has a forward voltage drop of 0.7 V.

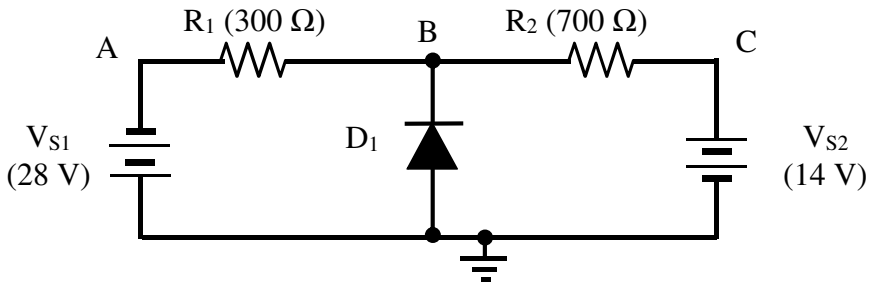

Figure B2

B3. The circuit shown in Figure B3 is a Zener diode regulator circuit. Given V_{ZT} = 6.2 V at I_{ZT} = 60 mA; I_{ZK} = 1 mA; Z_Z = 12 Ω; and V_{ZM} = 6.8 V.

(a) Find I_{ZM} of the Zener diode. **110 mA** [4 marks]

(b) If I_{ZM} is to flow through the Zener diode, determine:

i) The current flowing through 33Ω resistor R ($I_{33Ω}$) **157.6 mA** [2 marks]

ii) The current flowing through variable resistor R_L (I_L) **47.6 mA** [4 marks]

(c) What should be the power rating of resistor R? Choose from the available list: 0.25W, 0.5W, 1W, and 2W. **1W** [4 marks]

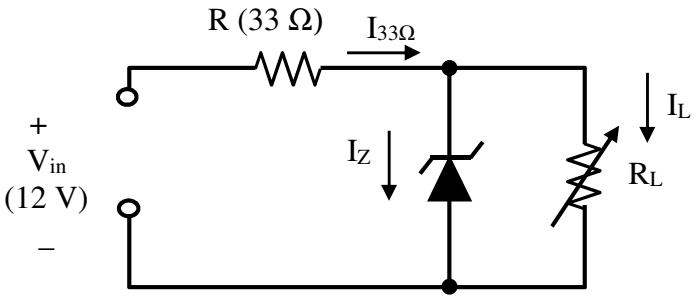

Figure B3

B4. The circuit in Figure B4 has the following parameters:

V_{BB} = 4 V, V_{CC} = 12 V, R_B = 10 kΩ, R_C = 150 Ω, transistor's β = 180 and $V_{CE(sat)}$ = 0.2 V.

(a) Determine the emitter current I_E and voltage across transistor V_{CE}.

59.73 mA **3.09 V** [8 marks]

(b) Is the transistor operating in the saturation or active mode? Give a reason for your answer.

Active mode
Reason : V_{CE} is not less than 0.2 V [4 marks]

(c) Is the transistor used in this circuit an NPN or a PNP transistor? [2 marks]

An NPN transistor

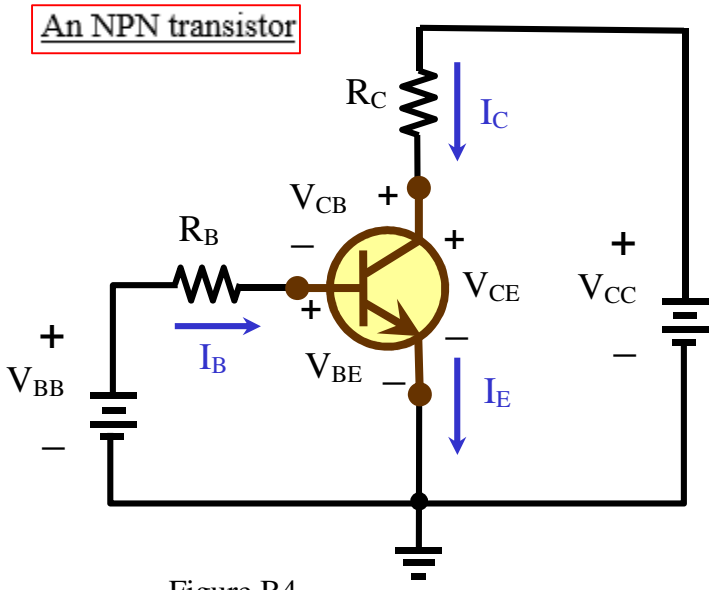

Figure B4

B5. (a) List three commonly used transducers, giving their full names. (Abbreviations are not accepted) [3 marks]

light dependent resistor
thermistor
moisture sensor

(b) The transducer circuit in Figure B5 works under the following conditions:

(i) The bulb is turned OFF when the LDR is exposed to surrounding ambient light. The voltage V_{LDR} is 0.6 V when the bulb remains OFF.

(ii) The bulb is turned ON when the LDR is covered to cut off its exposure to light. The voltage V_{LDR} is 4.2 V when the bulb is ON and the transistor is saturated.

Assume:
1) V_{CE} = 0.2 V when the transistor is saturated
2) Bulb resistance is 200 Ω

(i) Calculate the resistance range of the LDR. [6 marks]

Range of R_{LDR} = 714.3 Ω to 8.75 kΩ

(ii) Calculate I_C and V_{CE} when the bulb is in its OFF state, and when it is in its ON state. [5 marks]

When the light bulb is in the OFF state:
I_C = 0 A
V_{CE} = 9 V

When the light bulb is in the ON state:
V_{CE} = 0.2 V
I_C = 44 mA

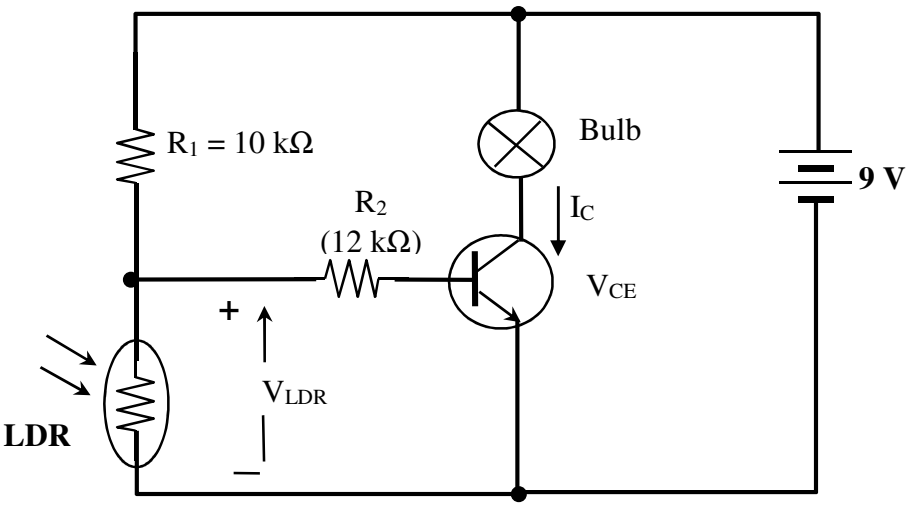

Figure B5

- End of Paper –

Formulae

Energy, Work Done, Charge, Power:

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

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

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:

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

Centre-Tapped Full-Wave Rectifier:

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

Bridge Full-Wave Rectifier:

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

Ripple Factor:

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

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

Transistors:

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

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

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