FIJI NATIONAL UNIVERSITY
College of Engineering, Science & Technology

TRADE DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE476: ANALOG ELECTRONICS 1.

FINAL EXAMINATION - TRIMESTER 3 - 2017.

DURATION: 3 HRS. **TOTAL NO OF PAGES: 10**

DATE: TBA **TIME:** TBA **VENUE:** TBA

INSTRUCTIONS TO STUDENTS:

1. You are allowed 10 minutes **EXTRA** as reading time during which you are **NOT** to write.
2. Begin each answer on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each attached sheet.
4. Insert all written foolscap, graph paper, drawing paper, etc. in their correct sequence and secure well.
5. For all sheets of paper on which rough/draft work has been done, cross it through and attach to your answer scripts.
6. Show all workings where necessary
7. Diagrams and graphs can be drawn in pencil.
8. Non- programmable calculators are allowed.
9. **Attempt all questions!**
10. Check your work before you leave the room!!

Section A: MULTIPLE CHOICE **(10 marks)**

Answer ALL questions by writing down the correct alphabet besides the question number.

1. Valence electrons of an element are:

   (a). In the closest orbit to the nucleus
   (b). In the most distant orbit from the nucleus
   (c). In various orbits around the nucleus
   (d). In the nucleus of the atom

2. The current in a semiconductor is produced by:

   (a) electrons only
   (b) holes only
   (c) negative ions
   (d) both electrons and holes

3. The purpose of a pentavalent impurity is to:

   (a) reduce the conductivity of the silicon
   (b) increase the number of holes
   (c) create minority carriers
   (d) increase the number of free electrons

4. The term "bias" means:

   (a) the ratio of majority carriers to minority carriers
   (b) the amount of current across a diode
   (c) DC voltage is applied to control the operation of a device.
   (d) there is an avalanche current

5. The majority carrier in an n-type semiconductor are:

   (a) holes
   (b) valence electrons
   (c) conduction electrons
   (d) protons

6. A diode is normally operated in:

(a) reverse breakdown
(b) forward bias region
(c) reverse bias region
(d) either (b) or (c).

7. The average value of a half-wave rectifier voltage with a peak value if 200V is:

(a) 63.7V
(b) 127V
(c) 141V
(d) 0V

8. The total secondary voltage in a centre-tapped full-wave rectifier is 125Vrms. Neglecting the diode drop, the rms output voltage is:
(a) 125V
(b) 177V
(c) 100V
(d) 62.5V

9. The three terminal of a BJT are:

(a) pnp
(b) npn
(c) input, output and ground
(d) base, emitter & collector

10. Once a BJT is in saturation region, a further increase in base current will:

(a) cause collector current to increase
(b) not affect the collector current
(c) cause the collector current to decrease
(d) turn the transistor off

Section B SHORT ANSWERS [2 marks each] **[30 marks]**

No	Question	Answer
1.	Define "doping" as used in semiconductors?	
2.	What does the "depletion layer" refers to in the pn junction	
3.	What is the typical "*barrier potential*" of a silicon diode compared to a germanium diode	
4.	The atomic number for silicon is 14, explain the distribution of electrons in each cell or orbit?	
5.	Describe how the pn junction is formed?	
6.	Give a reason why silicon is the 1st choice rather than the germanium semiconductor.	
7.	What is the maximum number of electrons that can exist in the 3rd cell of an atom?	
8.	What is a major application for zener diode and explain how it operates?	
9.	Explain why a series resistor is necessary when a diode is forward biased?	
10.	What is your understanding when a BJT transistor is in a condition called "forward-reverse bias"	
11.	Lists 2 of the 3 main categories Manufacturers classify BJT transistors.	
12.	Explain the reason why a BJT is called a bipolar device	
13.	A certain zener diode has V_z = 7.5V and Z_z = 5 ohms at a certain current. Draw the equivalent circuit.	
14.	List the 3 main characteristic of a practical operational amplifier.	
15.	What kind of op-amp is a "voltage-follower"?	

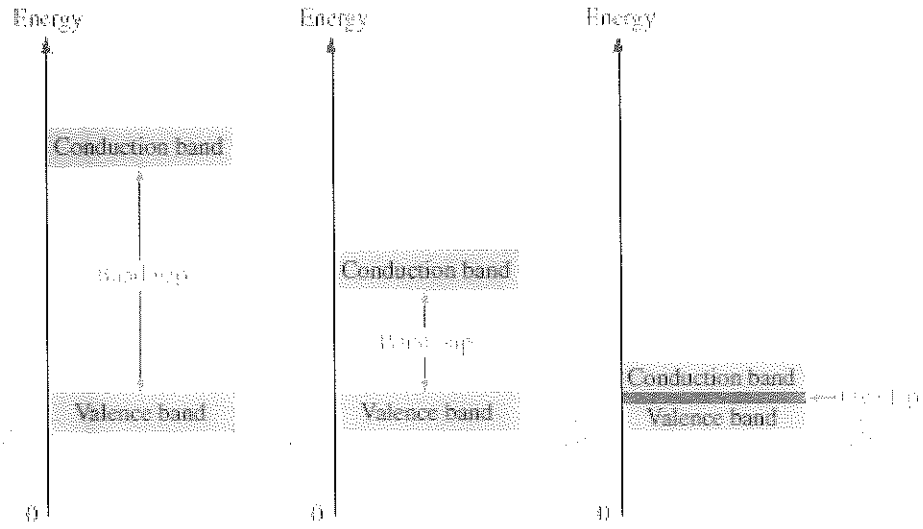
SECTION C **Theory & Explanation** **TOTAL: [60 marks]**

Question 1. **Rectifiers/Semi-conductors & Diodes** **[15 marks]**

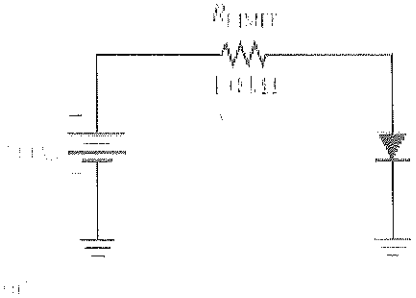
a) Define the following terms: (3 marks)
   i) Atomic number
   ii) Valence Electrons
   iii) Semi-conductor

b) If the atomic number of a neutral atom is 14, show in a diagram the shell/orbit levels and the number of electrons in each level? (3 marks)

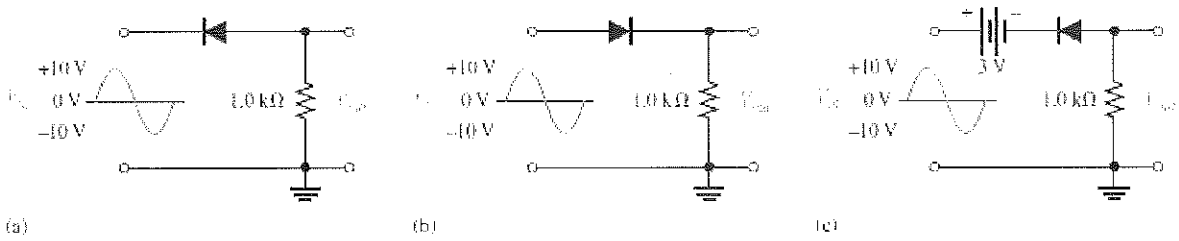
c) For each of the energy diagram below, determine the class of material each represents? (3 marks)



d) Determine the forward voltage and forward current for the diode in the figure (a) below for each of the diode models. Also determine the voltage across the limiting resistor. (3 marks)

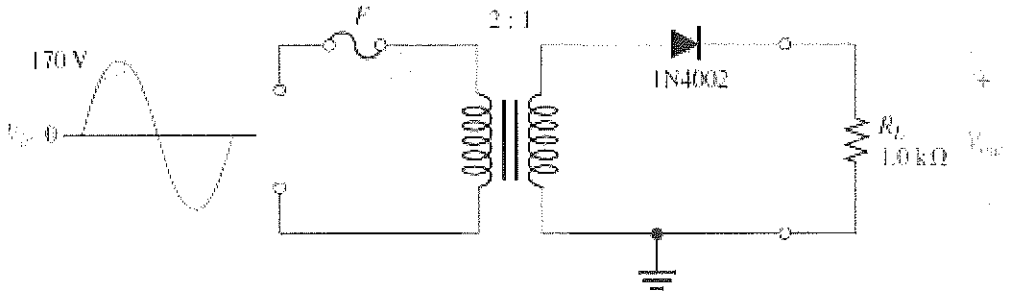


e) Draw the output voltage waveform of the circuits shown below and include their values: (3 marks)

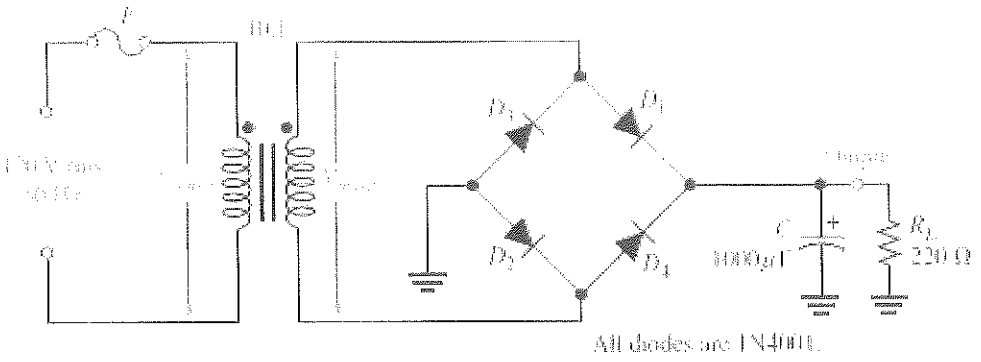


Question 2: Linear Power Supply & Switched-Mode Power Supply [15 marks]

a) Determine the peak value of the output voltage for the diagram below if the turns ratio is 2:1? (3 marks)



b) Calculate the ripple factor for a filtered bridge rectifier shown below: (8 marks)



c) Draw a block diagram of a switched mode power supply and describe the function of each block (4 marks)

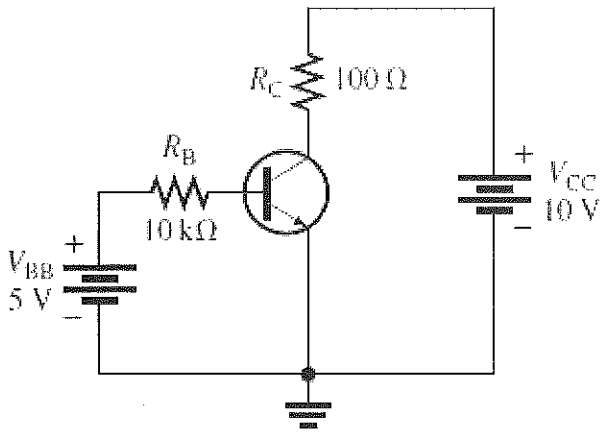
Question 3. BJT, BIASING & AMPLIFICATION & FET [15 marks]

a) What are the three terminals (regions) of a BJT and describe the levels of their doping? (1 mark)

b) Draw the symbols of an npn and pnp BJT transistors (1 mark)

c) Explain how a BJT is biased in normal operation (1 mark)

d) Calculate I_C, I_B, I_E, V_{CE}, V_{BE} and V_{CB} in the circuit shown below; β_{DC} of the transistor is 150. (6 marks)



e) Show and label in diagrams the basic structure of the 2 types of JFET
(2 marks)

f) List and explain the 4 main differences of FET to BJT.

(4 marks)

Question 4. BJT CHARACTERISTICS & APPLICATION [15 marks]

a) Shown below in Figure 1b is the BJT Collector Characteristic curve (I_C versus V_{CE} characteristic curve) for a single value of I_B for the circuit in Figure 1a.

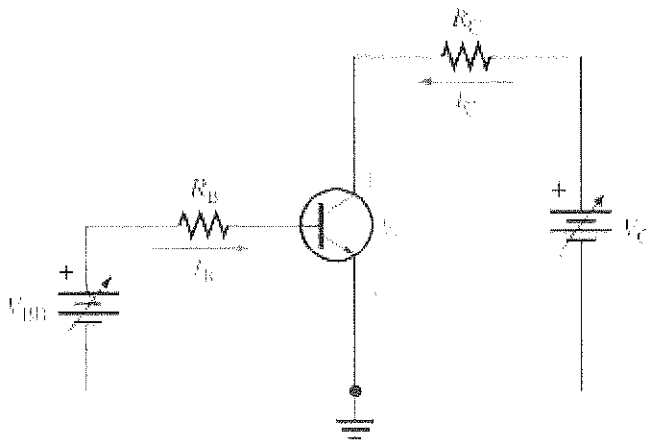


Figure 1a

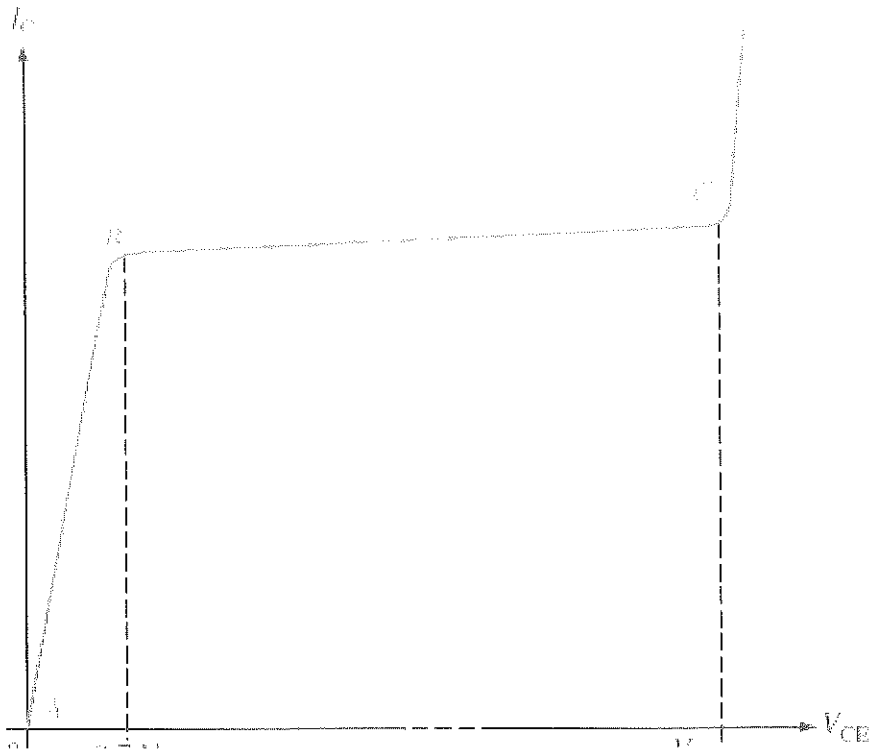
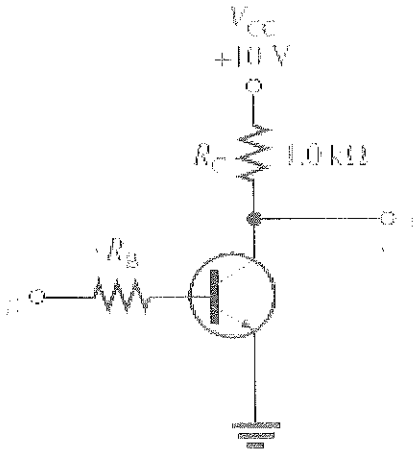


Figure 1b

i) Clearly mark the 3 operating regions of the BJT (3 Marks)

ii) Discuss the points marked A, B & C and each region in terms of voltages and currents. (8 Marks)

b) Another application of BJT is to function as a "switch". By referring to the circuit below:



i) Calculate the minimum value of I_B that will saturate the transistor if β_{DC} = 200? (2 marks)

ii) Calculate the maximum value of R_B when V_{IN} = 5V (2 marks)

THE END

Key Formulas

$I_E = I_C + I_B$	Transistor currents
$\beta_{DC} = \frac{I_C}{I_B}$	DC current gain
$V_{BE} \cong 0.7\ \text{V}$	Base-to-emitter voltage (silicon)
$I_B = \frac{V_{BB} - V_{BE}}{R_B}$	Base current
$V_{CE} = V_{CC} - I_C R_C$	Collector-to-emitter voltage (common-emitter)
$V_{CB} = V_{CE} - V_{BE}$	Collector-to-base voltage
$A_v \cong \frac{R_C}{r'_e}$	Approximate ac voltage gain
$V_{CE(cutoff)} = V_{CC}$	Cutoff condition
$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C}$	Collector saturation current
$I_{B(min)} = \frac{I_{C(sat)}}{\beta_{DC}}$	Minimum base current for saturation
$I_C = \beta_{DC} I_\lambda$	Phototransistor collector current

$N_e = 2n^2$	Maximum number of electrons in any shell

$$I_F = \frac{V_{BIAS}}{R_{LIMIT}}$$ Forward current, ideal diode model

$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}}$$ Forward current, practical diode model

$$V_{AVG} = \frac{V_p}{\pi}$$ Half-wave average value

$$V_{p(out)} = V_{p(in)} - 0.7\text{ V}$$ Peak half-wave rectifier output (silicon)

$$\text{PIV} = V_{p(in)}$$ Peak inverse voltage, half-wave rectifier

$$V_{AVG} = \frac{2V_p}{\pi}$$ Full-wave average value

$$V_{out} = \frac{V_{sec}}{2} - 0.7\text{ V}$$ Center-tapped full-wave output

$$\text{PIV} = 2V_{p(out)} + 0.7\text{ V}$$ Peak inverse voltage, center-tapped rectifier

$$V_{p(out)} = V_{p(sec)} - 1.4\text{ V}$$ Bridge full-wave output

$$\text{PIV} = V_{p(out)} + 0.7\text{ V}$$ Peak inverse voltage, bridge rectifier

$$r = \frac{V_{r(pp)}}{V_{DC}}$$ Ripple factor

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$ Peak-to-peak ripple voltage, capacitor-input filter

$$V_{DC} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$ DC output voltage, capacitor-input filter

$$\text{Line regulation} = \left(\frac{\Delta V_{OUT}}{\Delta V_{IN}}\right)100\%$$

$$\text{Load regulation} = \left(\frac{V_{NL} - V_{FL}}{V_{FL}}\right)100\%$$