UNIVERSITY OF JOHANNESBURG

PROGRAM : NATIONAL DIPLOMA
ENGINEERING: ELECTRICAL
ENGINEERING: COMPUTER SYSTEMS

SUBJECT : **ELECTRONICS I**

CODE : **EEL1111**

DATE : WINTER SUMPLEMEMTARY EXAMINATION
22 JULY 2015

DURATION : (SESSION 2) 11:30 – 14:30

WEIGHT : 40: 60

TOTAL MARKS : 105

FULL MARKS : 100

EXAMINER : MR NE MABUNDA

MODERATOR : MR HP VAN DER WALT 2010

NUMBER OF PAGES : 9 PAGES AND 1 ANNEXURE

INSTRUCTIONS : ONE POCKET CALCULATOR PER STUDENT.

INSTRUCTION TO CANDIDATES:

1. 100 MARKS = 100% TOTAL MARKS AVAILABLE = 105
2. ATTEMPT ALL QUESTIONS.
3. THEORY TYPE QUESTIONS MUST BE ANSWERED IN POINT FORM BY CAREFULLY CONSIDERING THE MARK ALLOCATION.
4. ALL DIAGRAMS AND SKETCHES MUST BE DRAWN NEATLY AND IN PROPORTION.
5. ALL DIAGRAMS AND SKETCHES MUST BE LABELLED CLEARLY.
6. ALL WORK DONE IN PENCIL EXCEPT DIAGRAMS AND SKETCHES WILL BE CONSIDERED AS ROUGH WORK AND WILL NOT BE MARKED.
7. **NOTE**: MARKS WILL BE DEDUCTED FOR WORK WHICH IS POORLY PRESENTED.
8. QUESTIONS MAY BE ANSWERED IN ANY ORDER, BUT ALL PARTS OF A QUESTION MUST BE KEPT TOGETHER.
9. **TAKE THE FORWARD BIASED VOLTDROP ACROSS ALL PN JUNCTIONS AS 0,6 VOLT UNLESS OTHERWISE STATED.**
10. QUESTION 1 MUST BE ANSWERED ON THE ANSWER SHEET PROVIDED (AT THE BACK OF YOUR EXAM SCRIPT).

QUESTION 1

- Choose the letter that represents the correct answer and indicate this answer on the answer sheet provided at the back of your exam script.
- **NOTE**: Only one answer is **100% correct and negative marking applies.**
- This means that for every two incorrect answers recorded one mark will be deducted from the total scored for this question.
- Each question counts 1 mark

3/...

QUESTION 1 (CONTINUED)

1.1 Which statement is **false**?

(a) Extrinsic semiconductors are materials where impurity atoms have been added.
(b) A decrease in the temperature of a semiconductor can result in a substantial decrease in the number free electrons in the material.
(c) Semiconductors such as Ge and Si show a reduction in resistance with an increase in temperature.
(d) Bonding of atoms as a result of the atoms possessing opposite electrical charges and this attracting one other is called covalent bonding.

1.2 A PN Junction is formed when:

(a) Pure silicon into which a small number of arsenic atoms have been diffused.
(b) Pure germanium into which a small number of boron atoms have been diffused.
(c) Two oppositely material are brought together.
(d) None of the above.

1.3 Forbidden energy gap of a conductor is:

(a) equal to 0 eV.
(b) equal to 6 eV .
(c) equal to 1 eV .
(d) none of the above.

1.4 The reasons for doping semiconductors include:

(a) creating linear increase of semiconductor conductivity over a temperature domain.
(b) reducing charge carriers on conduction band.
(c) to ensure a stable conductivity by a semiconductor.
(d) none of the above.

1.5 The resistivity of a conductor:

(a) is less than that of a semiconductor.
(b) is highly affected by temperature changes.
(c) is less than that of an insulator.
(d) none of the above

QUESTION 1 (CONTINUED)

1.6 Listed are statements, concerning the energy gap (Eg) between the valence band and the conduction band. Identify the true one:

(a) The Eg for silicon = 0,67 eV.
(b) The Eg for conductors = 0 eV and for semiconductors = 5 eV.
(c) The Eg for semiconductors < 0,67 eV and for conductors Eg > 5 eV.
(d) The Eg for conductors = 0 eV and for insulators Eg > 5 eV.

1.7 In a N-type semiconductor electrons can easily take part in the conduction process and are called:

(a) acceptor atoms
(b) donor atoms
(c) negative ions
(d) majority current carriers

1.8 Study the following statements and identify the correct one.

(a) The introduction of impurities into semiconductor materials such as silicon, increases its conductivity.
(b) Extrinsic semiconductor materials are those that have been carefully refined to reduce the impurities to a very low level.
(c) An increase in temperature of a semiconductor can result in a substantial decrease in the number of electrons in the material.
(d) A semiconductor that has been subjected to the doping process is called an intrinsic material.

1.9 A germanium diode, in the forward biased condition, has a potential difference across it because:

(a) the current carriers, within the p and n-type semiconductor material, first have to neutralize the depletion region.
(b) the current carriers, within the p and n-type semiconductor material, take time to reach the junction.
(c) the current carriers, within the p and n-type semiconductor material, first have to move from the valence band into the conduction band.
(d) all of the above.

QUESTION 1 (CONTINUED)

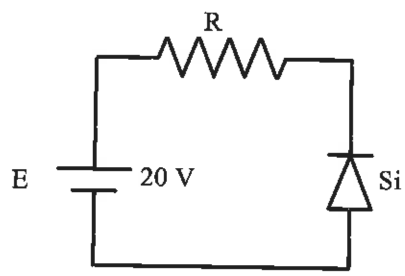
1.10 Which of the following relationships relates capacitance in a junction diode.

(a) The current which flows when light falls on the photodiode's junction is called dark current.
(b) Current flow due to minority carriers flowing from cathode to anode.
(c) Current flow is due to minority carries flowing from anode to cathode.
(d) None of the above.

1.11 As light increases in a photo diode

(a) an increased number of free electrons
(b) a decreased number of free electrons
(c) reduced conduction
(d) relatively unchanged conduction

1.12 Consider the following circuit diagram:



When a voltmeter is placed across the diode, it will read a voltage approximately equal to:

(a) the diode barrier potential
(b) 0 V
(c) 20 V
(d) 19,4 V

1.13 Consider the diagram in question 1.12. Should the voltmeter be placed across the resistor, it will read a voltage approximately equal to

(a) 20 V
(b) 0 V
(c) the reverse bias voltage of the diode
(d) 19,4 V

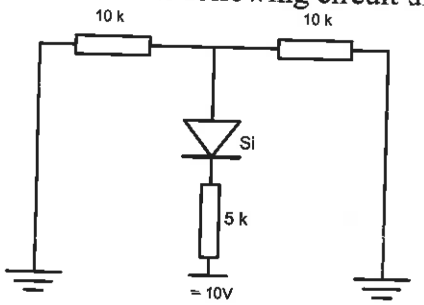
QUESTION 1 (CONTINUED)

1.14 Consider the diagram in question 1.12.

If the diode is replaced with an ideal diode:

(a) The voltage V_{RL} = the supply voltage.
(b) The maximum current in the circuit = 0 mA
(c) The voltage $V_{RL} = 0.53$ V
(d) The maximum current in the circuit = $\frac{E}{R}$

1.15 Consider the following circuit diagram.



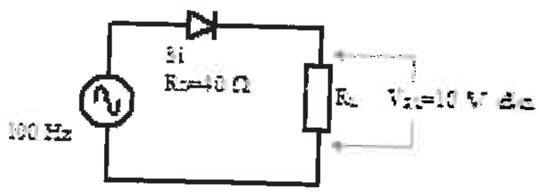
Calculate the volt drop across the 5 k resistor.

(a) 4,7 V
(b) 9,6 V
(c) 9,4 V
(d) 10 V

1.16 Calculate the volt drop across any of the 10 kΩ resistors.

(a) 4,4 V
(b) 2,35 V
(c) 4,7 V
(d) 5 V

1.17 Consider the following circuit:



Calculate the peak voltage across supply

(a) 16,01 V
(b) 32,02 V
(c) 64 V
(d) 20 V

QUESTION 1 (CONTINUED)

1.18 Consider the diagram in question 1.17

The RMS supply voltage equals:

(a) 32,02 V
(b) 8,154 V
(c) 22,647 V
(d) 16.01 V

1.19 Consider the diagram in question 1.17.

The peak current flowing in the circuit equals:

(a) 15 mA
(b) 785,5 mA
(c) 173,2 mA
(d) 500 mA

1.20 If $I_B = 100\mu A$ and $\beta = 100$ then I_E equals?

(a) 1,01 mA
(b) 10,100 mA
(c) 10,100 μA
(d) 1,01 μA

[20]

QUESTION 2 (SEMI CONDUCTOR PHYSICS)

2.1 Sketch labeled graphs to illustrate the difference in conductivity between intrinsic and extrinsic semiconductors. (6)

2.2 With the aid of block diagrams explain the differences between conductors and semiconductor materials. (6)

2.3 With the aid of diagrams explain the kind of bonding that can be formed by silicon atoms and phosphorus atoms. (6)

2.4 Define the term acceptor doping as used in semiconductors. (2)

[20]

QUESTION 3 (PN DIODES)

3.1 Use neat labeled forward characteristic curves to illustrate the differences in forward voltage between germanium, silicon and the gallium arsenide diodes. Label all your axes with typical values of voltage and current. (5)

3.2 Given a silicon diode that has a forward voltage drop of 0.65 V at 20 °C. Calculate the Junction temperature at which its forward voltage drop be reduced to 200 mV? Assume that the current remains constant, and the forward volt-drop changes by 2.5 mV per °C. (5)

[10]

QUESTION 4 (POWER SUPPLIES AND OSCILLOSCOPE)

4.1 A Centre-tapped transformer with a step-down ratio of 10:2, supplied with mains voltage of 230 V rms at 50 Hz is connected to a full-wave rectifier circuit using two silicon diodes with a 1 kΩ load resistor (R_L).

The following questions are relevant to the above description.

4.1.1 Sketch the circuit diagram of the circuit described. (6)
4.1.2 Calculate the average value of the DC current trough R_L (8)
4.1.3 What should the minimum PIV of the diodes be? (2)

4.1.4 Sketch on the attachment (display answer sheet provided), the input voltage waveform that would be measured by an oscilloscope, across the entire transformer secondary of the circuit. Illustrate two complete cycles which covers between 3 and 4 vertical divisions. (4)

4.1.5 Calculate the time and voltage per division setting of your oscilloscope. (4)

4.1.6 Sketch on the attachment (display answer sheet provided), the output voltage waveform as would be measured by an oscilloscope across the load resistor. Use the time per division and voltage per division that you have calculated in 4.1.5 (6)

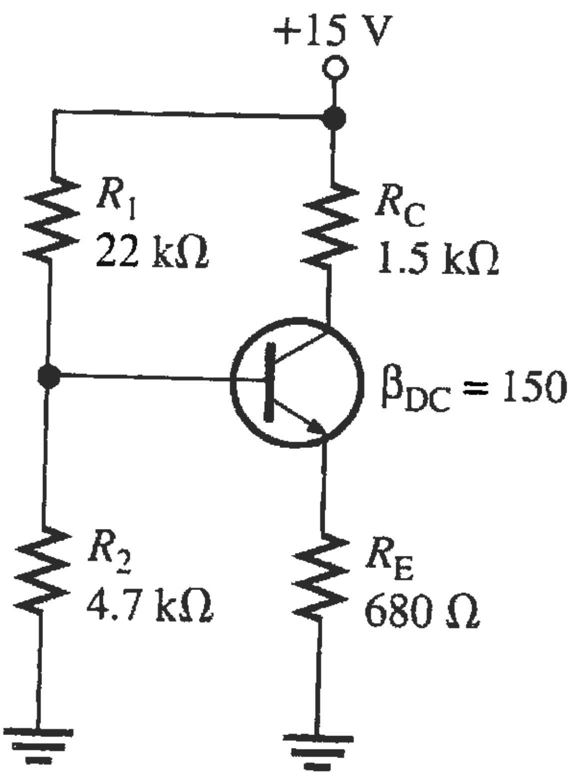
4.2 Identify the knob/button (found on the front panel of an oscilloscope) which you can use to perform the following adjustment on your display(s).

4.2.1 Change light intensity (1)
4.2.2 change number of displayed cycles, (1)
4.2.3 change the number of vertical division covered by the signal, (1)
4.2.4 to disconnect input signal, (1)
4.2.5 and to move the complete signals left or right. (1)

[35]

QUESTION 5 (BJT)

Calculate all the DC bias currents for the circuit shown below.



[10]

QUESTION 6 (FET)

6.1 Sketch a labeled diagram showing the basic construction of an N-channel depletion type MOSFET. (8)

6.2 What is the major difference between an enhancement and depletion MOSFET? (2)

[10]

TOTAL MARKS = 105
FULL MARKS = 100

ELECTRONICS 1 EEL111

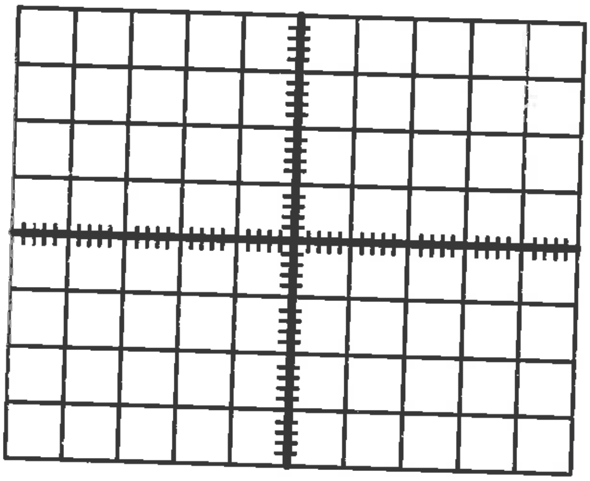
SURNAME: ______________ **INITIALS:** ________

STUDENT No: ______________

QUESTION 4.1.4 - 4.1.6
ANSWER SHEET

GRATICULES OF OSCILLOSCOPE
(To be handed in with your answer script)

Waveforms



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