TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATIONS 2016/2017
FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2212: PHYSICAL ELECTRONICS II

END OF SEMESTER EXAMINATIONS

SERIES: MAY, 2016

TIME: 2 HOURS **PAPER 2**

INSTRUCTIONS:
1. You should have the following for this examination:
   - Answer booklet
   - Non-Programmable Scientific calculator

2. This paper consists of **FIVE** questions
3. Answer **ANY**T**HREE**Questions.
4. All questions carry equal marks
5. Do not write on the question paper.

5. This paper consists of FOUR printed pages.

Question ONE

(a) Name any **TWO**:

(i) Electro-optical transducers

(ii) Opto-electronic transducers

(2 marks)

(b) (i) Explain the photoconductive effect.

(ii) Hence explain how the energy gap of a semi-conductor can be measured.

(5 marks)

(c) Describe the principle of operation and the shape of the typical characteristics curves of the following devices:

(i) Photoconductive cell
(ii) Bipolar phototransistor
(iii) Solar cell

(8.5 marks)

(d) For each of the devices mentioned in (c) above:

(i) Draw circuit symbol
(ii) State the material used in construction
(iii) Mention one application

(4.5 marks)

Question TWO

(a) Define Field-Effect Transistor.

(b) Consider an enhancement and a depletion type MOSFET.

(i) Draw the circuit symbols

(ii) Explain the reason for the gap separating the gate from the rest of the symbol.

(iii) Explain also the solid line in the depletion MOSFET and a broken line in the enhancement MOSFET.

(6.5 marks)

(c) In practice JFETs have an symmetrical structure. Show the relationship between $I_{D(sat)}$ *and* V_{Dss} is found to be approximately:

$$I_{D(sat)} = V_{Dss}\left(1-\frac{V_{Gs}}{V_p}\right)$$ **(11 marks)**

(c) Find the pinch-off voltage of a silicon p-channel FET having half channel height of 2 microns and channel resistivity of 10Ω-cm. Dielectric constant of silicon is 12 and mobility of holes is $500cm^2/Vs$, $\varepsilon_o = 8.849 \times 10^{-12} F/M$. **(2.5 marks)**

Question THREE

(a) (i) Sketch the energy band diagram of NPN transistor at equilibrium and under normal biasing conditions.

(ii) Use this diagram to explain the operation of NPN transistor.

(6 marks)

(b) (i) List **FOUR** modes of operation of bipolar junction transistor (BJT). State the biasing conditions of each mode.

(ii) Draw the static common emitter output characteristics for a low-power Silicon NPN BJT and indicate on it the regions corresponding to EACH of the modes of operation of a BJT.

(7.5 marks)

(c) Write the equations for the terminal currents of the ideal transistors in terms of four internal currents.

(3 marks)

(d) (i) Find the collector current for a transistor when both emitter and collector junctions are reverse-biased. Assume $I_{CO} = 5\mu A,\ I_{EO} = 3.75\mu A$ *and* $\alpha_N = 0.98$.

(ii) Find the emitter current I_E under the same conditions as in (i) above.

(3.5 marks)

Question FOUR

(a) Consider UJT.

(i) Draw the equivalent circuit and sketch the typical characteristics.
(ii) Draw the circuit symbol.
(iii) Explain the principle of operation.

(9.5 marks)

(b) (i) With the aid of a sketch of the basic structure, explain the principle of operation of LED.

(ii) Explain **THREE** mechanisms of operation of LCD display.

(5.5 marks)

(c) (i) Explain what is meant by "population inversion" of energy levels in a material.

(ii) Draw the I-V a characteristics of a solar cell with varying illumination as a parameter. Indicate on the characteristics of I_{SC}, V_{oc} *and* I_{dark}.

(5 marks)

Question FIVE

(a) Draw a schematic diagram indicating the relative magnitudes of the various currents components in an NPN BJT operating in the active mode. **(2.5 marks)**

(b) (i) Explain what the term "unipolar" refers to?

(ii) State **FIVE** advantages of the FET over the BJT.

(3 marks)

(c) Briefly describe the base width modulation in BJT operation. **(4.5 marks)**

(d) (i) Sketch the basic structure of V-MOS and explain its principle of operation.

(ii) State **FOUR** advantages of V-MOS power FET.

(6 marks)

(e) Calculate the punch-through voltage for an NPN silicon transistor of the alloy type if W = 1μm and the resistivity, pB of the base.

$0.5\Omega,\ \varepsilon_r = 12,\ \varepsilon_o = 8.849\times10^{12} F/M,\ \mu_p = 500 cm^2/Vs$ **(4 marks)**