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UNIVERSITY EXAMINATIONS 2022/2023

THIRD YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF COMPUTER TECHNOLOGY

CIC 3354: MICROELECTRONICS CIRCUIT DESIGN

DATE: APRIL 2023 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Draw schematic and construction diagrams of both NPN and PNP Transistor and label the its regions (8 Marks)

b) Using first principles show that the following BJT transistor equation is true

$l_E = l_B(\beta_{DC} + 1)$

Where l_E and l_B are the DC emitter and base currents respectively and β_{DC} is the transistor's DC current gain (4 Marks)

c) Determine l_B, l_C, l_E, V_{CE}, andV_{CB} in the circuit of Figure I . The transistor has a $\beta_{DC=150}$. (10 Marks)

d) For the JFET in Figure 2, $V_{GS(off)=-4V}$ and $lDSS_{12mA}$.Determine the *minimum* value of V_{DD} required to put the device in the constant-current region of operation when $V_{GS=}0V$. If V_{DD} increased to 1 5 V, what is the drain current? (8 Marks)

QUESTION TWO (20 MARKS)

a) Determine whether or not the transistor in Figure 3 is in saturation. Assume $V_{CE(sat)=0.2V.}$

(8 Marks)

b) The transistor in Figure 4 has the following maximum ratings: $PD_{(max)} = 800\ mW, V_{CE(\max\ )} = 15\ V$,and$IC_{(\max\ )} = 100\ mA$. Determine the maximum value to which V_{CC} can be adjusted without exceeding a rating. Which rating would be exceeded first?

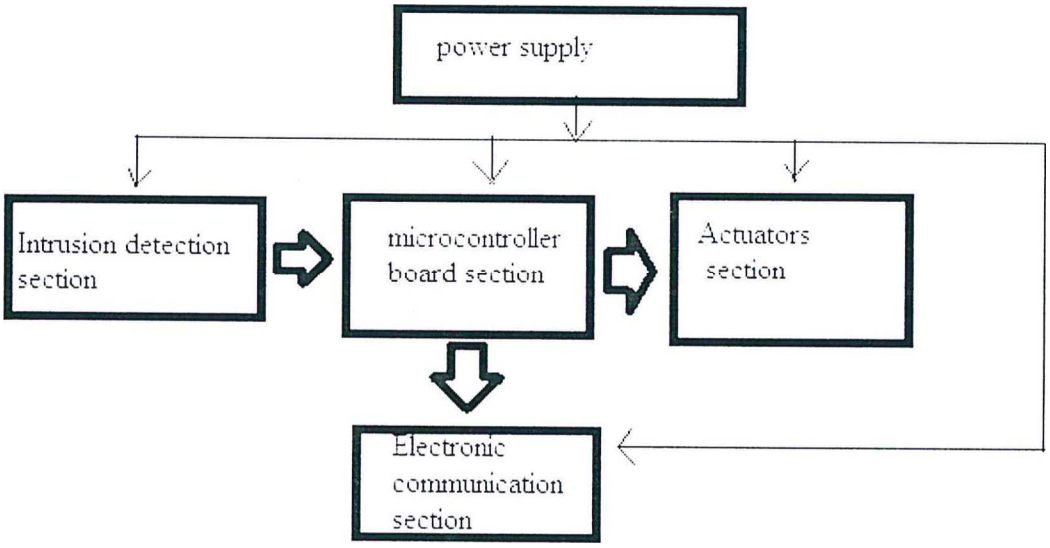
(8 Marks)

c) Show that the voltage gain of the following transistor amplifier is given by the equation $A_v = \frac{R_c}{r_e'}$ where r_e' is the transistor internal emitter resistance and R_c is the collector resistance.

(4 Marks)

QUESTION THREE (20 MARKS)

A circuit using transistor switches will be developed for use in an alarm system for detecting forced entry into a building. In its simplest form, the alarm system will accommodate four zones with any number of openings. It can be expanded to cover additional zones. For the purposes of this application, a zone is one room in a house or other building. The sensor used for each opening can be either a mechanical switch, a magnetically operated switch. or an optical sensor. Detection of an intrusion can be used to initiate an audible alarm signal and/or to initiate transmission of a signal over the phone line or internet to a monitoring service. The alarm system is to have three sections namely; the door sensing section, the microcontroller section, the actuators section and the signal transmission section as show in the figure below. Assume you have been assigned the responsibility of designing the electronic system for implementing the above described task.



a) With the aid of schematic diagrams describe the circuit for implementing the intrusion detection section given that the intruder is likely to get into the building by force the door to open. (5 Marks)

b) With the aid of a schematic diagram describe the circuit for switching on an AC (240 V) powered alarm system when an intrusion is detected (5 Marks)

c) What is the function of the microcontroller board in the above block diagram? (5 Marks)

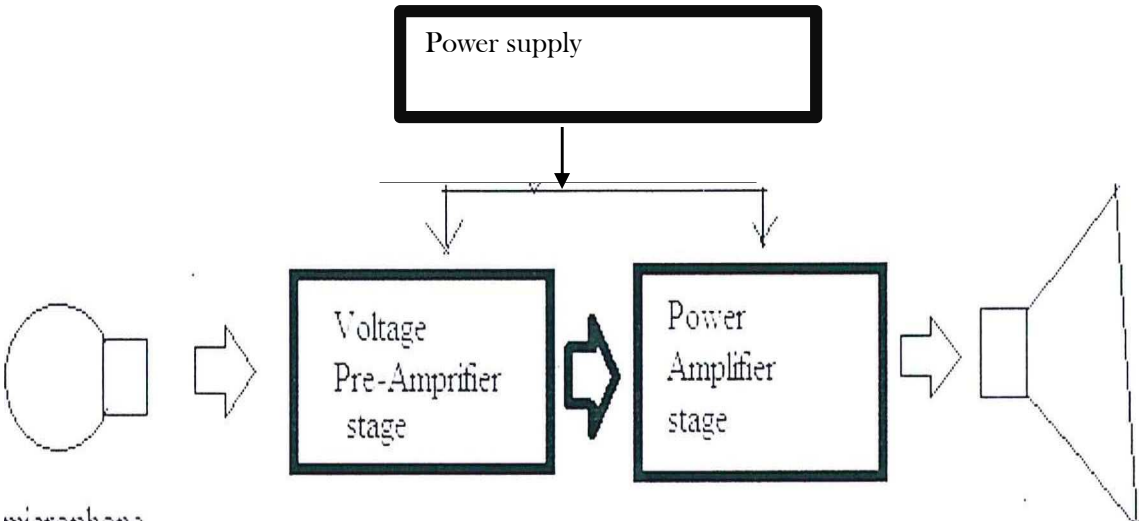
d) Describe what Internet of Things is and how it can be applied in the context in question (5 Marks)

QUESTION FOUR (20 MARKS)

a) List five differences between an ideal and practical Operational Amplifier (Op Amp). (10 Marks)

b) Why is a feedback loop necessary when designing a voltage pre-amplifier using an Op amp package? (3 Marks)

c) The block diagram below shows the sections of a public address system



Microphone loud speaker

With the aid of schematic diagrams explain how

a) Voltage pre-amplifier can be designed using an op-amp. (3 Marks)
b) Power amplifier can be implemented using BJT transistors. (4 Marks)