The Open University of Sri Lanka
B.Sc. Degree Programme, Level – 04
Final Examination – 2017/2018
PYU2262 – Electronics
Duration: 3 hours

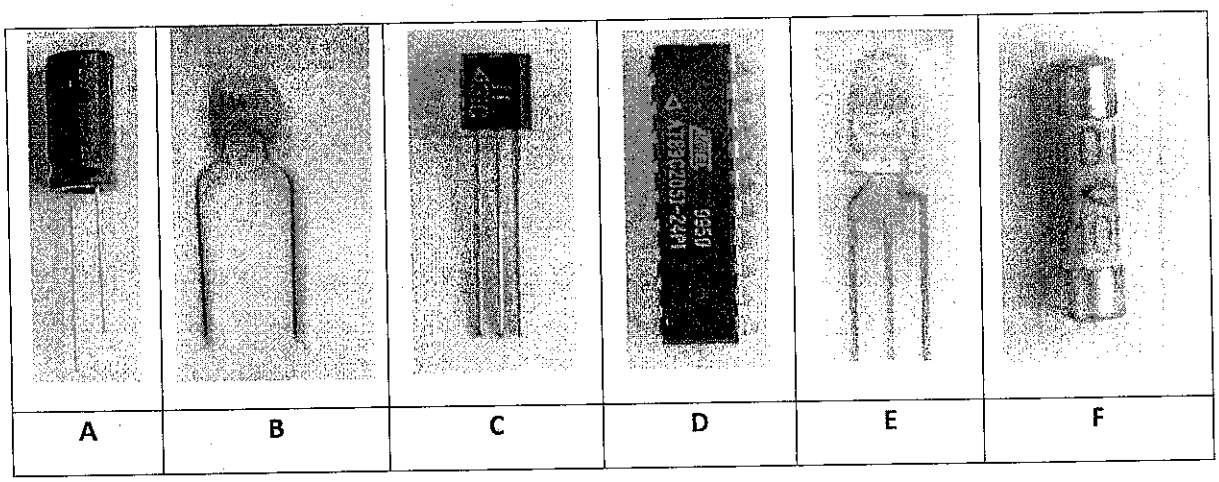
Date: 24th April 2019 **Time: 1.30 p.m. to 4.30 p.m.**

Answer all the questions in part A and any 5 questions from part B
Non-programmable calculators are allowed. All questions carry equal marks.

Part A

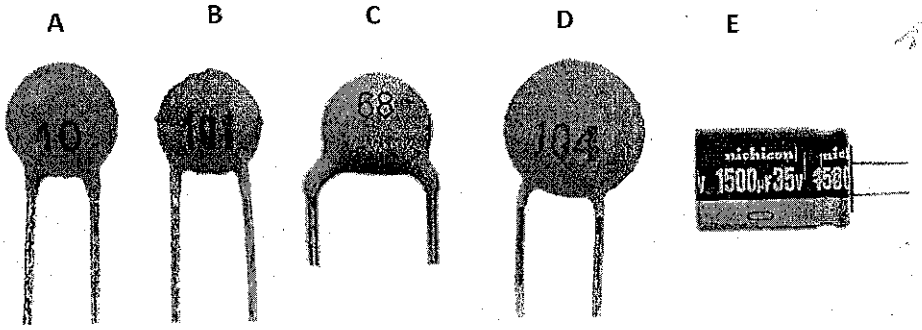
1)

a) Identify the component shown in the figure.

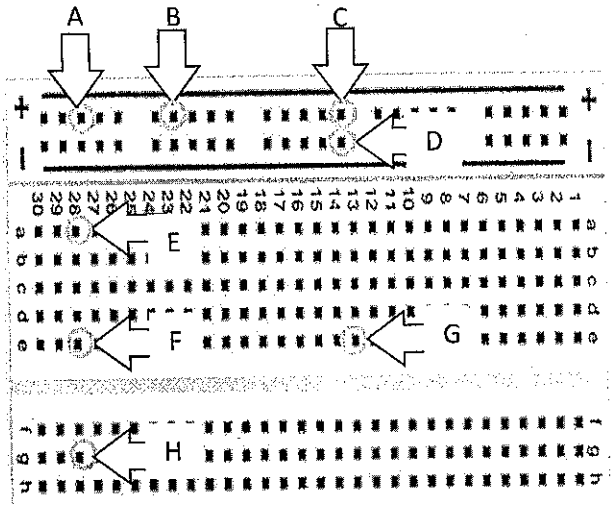


A	B	C	D	E	F

b) Write down the capacitance of each of the following capacitor



c) Prototype boards (plug boards / Solderless breadboards) are used to quickly build a circuit. Following is a diagram of a standard prototype board. Copy the following table to the answer script and fill it indicating whether the given points are internally connected to each other or not.



Points pair	Internally Connected ? (Y for yes, N for no)
A,B	
A,C	
C,D	
A,E	
E,F	
F,H	
F,G	

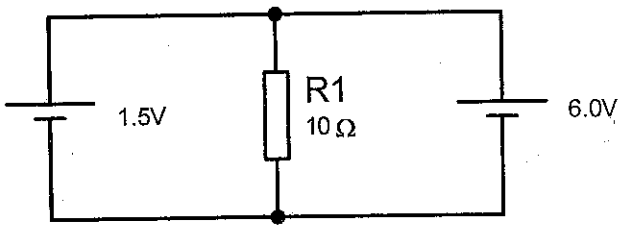
d) Before taking any reading, an oscilloscope needs to be calibrated. Briefly explain the steps in the calibration process.

Part B

1)

a) State Kirchhoff's laws

b) A student sees the following circuit diagram from a web site. He asks you to calculate the current through the R1 resistor using Kirchhoff's law. Comment on your results/ observations.



c) He later says batteries on the circuit are not ideal and have internal resistance. A battery with an internal resistance can be modeled as a voltage source and a resistance in series ~~to it~~. Redraw the circuit by replacing the batteries with above model given that Internal resistance of 1.5 V battery is 2 Ω and internal resistance of 6.0 V battery is 5 Ω). Draw a circuit diagram showing the internal resistances.

d) Recalculate the current through R1 resistor.

2)

a) According to Bohr's model of atom, electrons have definite energy levels. But in an energy band diagram for a solid they are represented as a band, which has a range of energy, and not as a single line with specific energy. Explain the reason for this.

b) A cylindrical copper wire of 3 mm diameter with conductivity of $5.8 \times 10^7\ \Omega^{-1}\ m^{-1}$ and electron mobility of $0.0032\ m^2\ V^{-1}\ s^{-1}$ is subjected to an electric field of $20\ mV\ m^{-1}$. Calculate the following.

i) Charge density of free electrons
ii) Current density
iii) Current flowing in the wire
iv) Electron drift velocity

3)

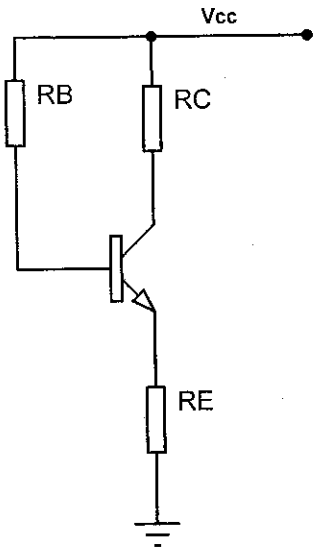


Figure 1

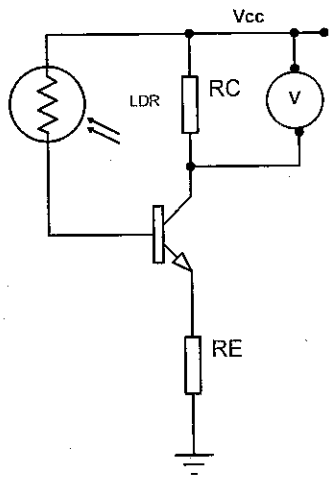


Figure 2

a) Consider the circuit in Figure 1. All notations have their standard meanings.
i) Obtain an expression for V_E using only the terms R_E and I_E
ii) Obtain an expression for I_B using only the terms V_{CC}, V_{BE}, V_E and R_B
iii) Write an expression for I_B, that contains only the terms $V_{cc}, V_{BE}, R_B, \beta$ & R_E.
iv) According to Ebers–Moll model, $I_C = \beta I_B$. Show that $I_C = \frac{\beta(V_{CC}-V_{BE})}{R_B+(1+\beta)R_E}$
v) If $\beta \gg 1$ and $\beta R_E \gg R_B$ show I_C is independent from the β

b) A student change the above circuit as follows. He replaces the R_B resistor with an LDR and connects a Voltmeter to measure V_{RC}. Resistance of the LDR changes from $100\ \Omega$ to $1\ k\Omega$ depending on the ambient light. He wants to show 5 V and 1 V in the voltmeter depending on the light and dark condition. Assuming $\beta = 100, V_{CC} = 6\ V, V_{BE} = 0.6\ V$, calculate suitable values for R_C and R_E.

4)

a)

i) Write down the characteristic truth table of a R-S Flip flop

ii) Design an active low S-R latch using NAND gates

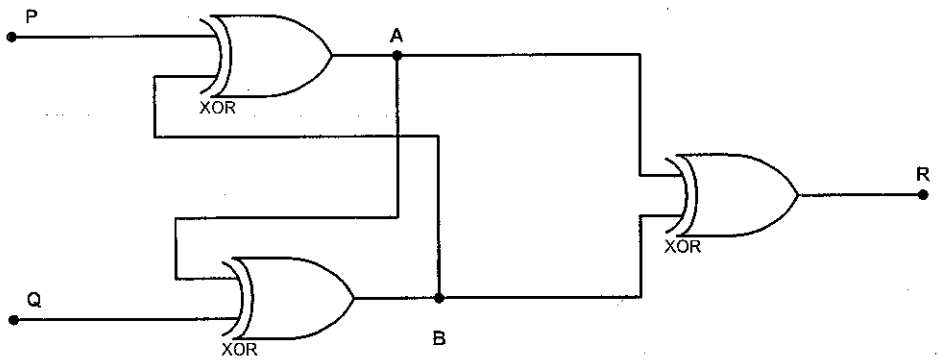
b) Consider the following circuit to find B and R if,

i) P = Q = A = 0

ii) P = Q = 0 ; A = 1

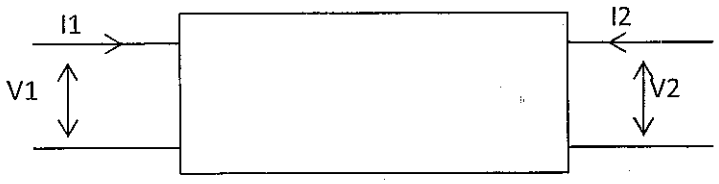
iii) P = Q = A = 1

iv) P =1 and Q = 0



5)

H-parameters (hybrid parameters) can be used to mathematically model a device or a circuit including transistors. Following diagram represents an unknown two port device. $V_1$and I_1 are the input voltage and current while V_2 and I_2 represent output voltage and output current respectively.



Relationship between these parameters are given by

$$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_i & h_r \\ h_f & h_o \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$$

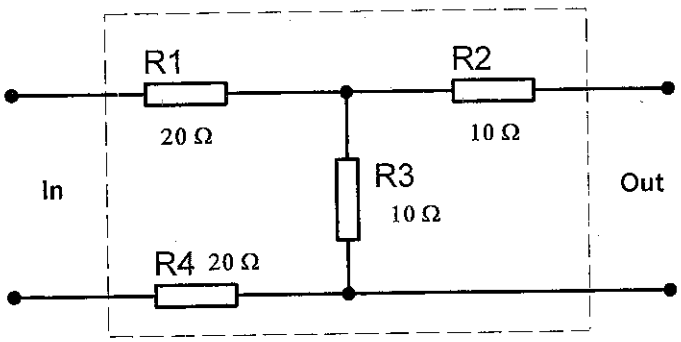
a)

i) By simplifying the above matrix, obtain two expressions for V_1 and I_2.

ii) Explain how you can determine h_i clearly specifying any conditions applied.

iii) Explain how you can determine h_r clearly specifying any conditions applied.

b) The internal structure of a two port device is as follows.



For the above device

i) Calculate h_i

ii) Calculate h_r

6)

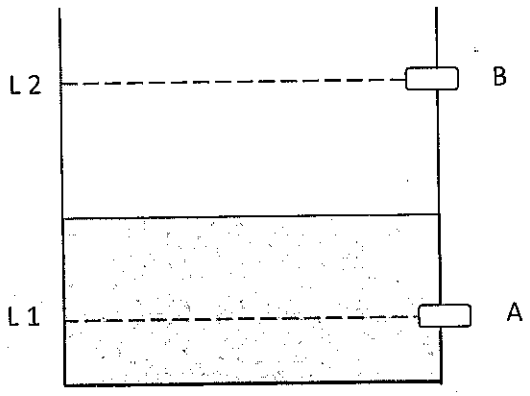
a) Convert the following decimal numbers to binary

i) 35_{10}

ii) 0.625_{10}

iii) 7.5_{10}

b) A student wants to make a circuit to control a water pump (Q) which fills a water tank. As illustrated in the following figure, two levels (L1 and L2) are marked on the tank. If water level falls below L1, the pump should start and continue until the tank is filled up to L2 level. When the water level reached L2 level, pump should stop and continue to be off until water level drops below L1. Two sensors named A and B are fixed at levels of L1 and L2 respectively. They output logic 1 if and only if water level is above the sensor. Pump will switch on as long as it receives logic 1 as its control signal.



i) Fill the blanks in the following characteristic table based on the description provided above.

Description	Present Pump State (Q_n)	Sensor A	Sensor B	Next Pump State (Q_{n+1})
Water level just dropped below L1	Off (0)	0	0	On (1)
Pump is working. Water level is between L1 and L2 and is rising	-------	1	-------	No change (Q_n)
Pump is working. Water level just reached L2	On(1)	-------	1	-------
Pump is stopped. Water level is between L1 and L2 and is falling	-------	-------	-------	No change (Q_n)

ii) Compare the last three columns (A, B and Q_{n+1}) with the characteristic truth table of active high J-K flip-flop. What is the change required to the input A, to match it with the characteristic table of J-K flip flops.

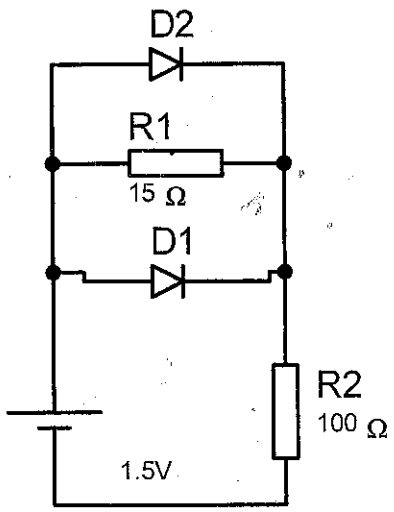
iii) Design a digital circuit using a J-K flip flop and any other logic gates required, to control the water pump as described in the question.

7)

In the following circuit, D_1 is a silicon diode with 0.6V potential barrier and D_2 is a Germanium diode with 0.3 V Potential barrier. ($V1 = 1.5\,V\,; R1 = 15\,\Omega; R2 = 100\,\Omega$)

a) Calculate the current through

i) D_1 Diode
ii) D_2 Diode
iii) R_1 Resistor



b) $R2$ resistor was changed to 10 Ω Calculate the current through

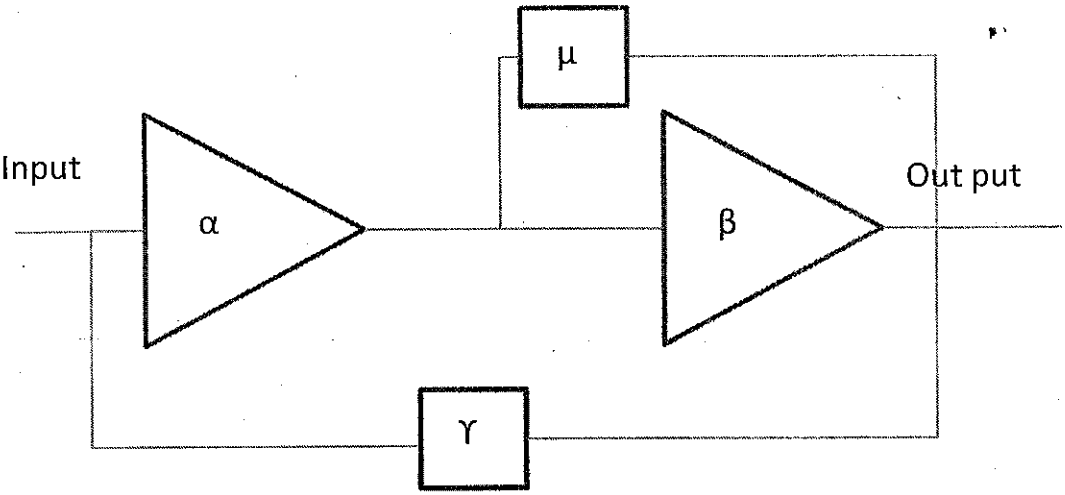
i) D_1 Diode
ii) D_2 Diode
iii) R_1 Resistor

c) Draw and label the internal structure of a JFET transistor.

8)

a) Name two advantages of using negative feedback in an amplifier circuit.

b) Consider the following diagram. Two amplifiers have gains of α and β respectively. Feedback ratio is γ and μ.



Derive an expression for the net gain of the circuit ($net\ gain = \frac{Output}{Input}$)

c) PIC16F887 microcontroller has a 10 bit analogue to digital converter (ADC). A student calibrates it so it can be used to measure the voltages from 0 V to 5 V.

i) Calculate the voltage resolution of the ADC.
ii) If 0 V is represented by 0000000000_2 What is the voltage represented by 1010000000_2?
iii) If the input voltage to the ADC is 2.5 V what would be the binary output of the ADC?

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