The Open University of Sri Lanka
B.Sc. Degree Programme, Level – 04
Final Examination – 2017/2018
PHU4301 – Electronics
Duration: 2 hours

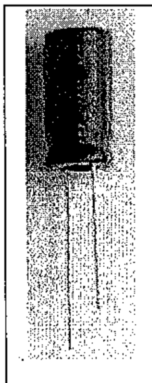
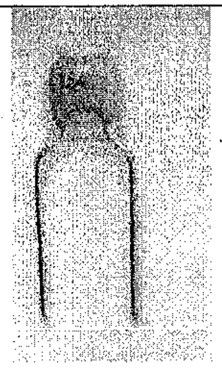
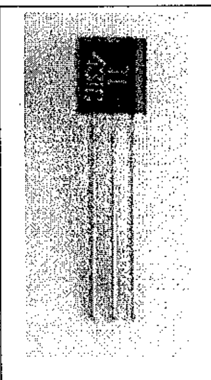
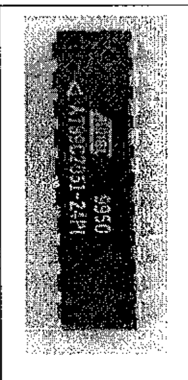
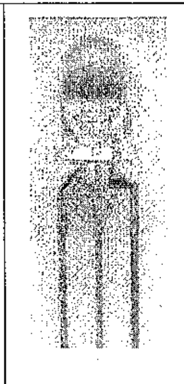
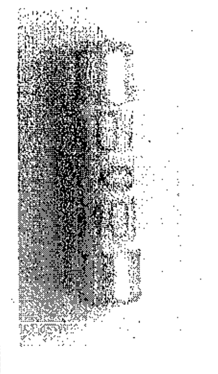
Date: 24th April 2019 **Time: 1.30 p.m. to 3.30 p.m.**

Answer all the questions in part A and any 3 questions from part B
Non-programmable calculators are allowed. All questions carry equal marks.

Part A

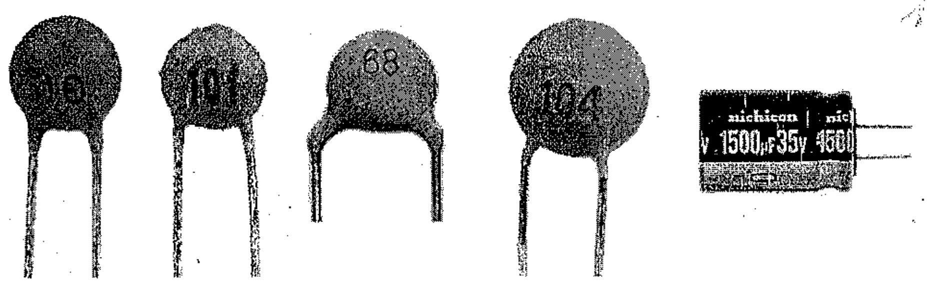
1)

a) Identify the component shown in the figure.

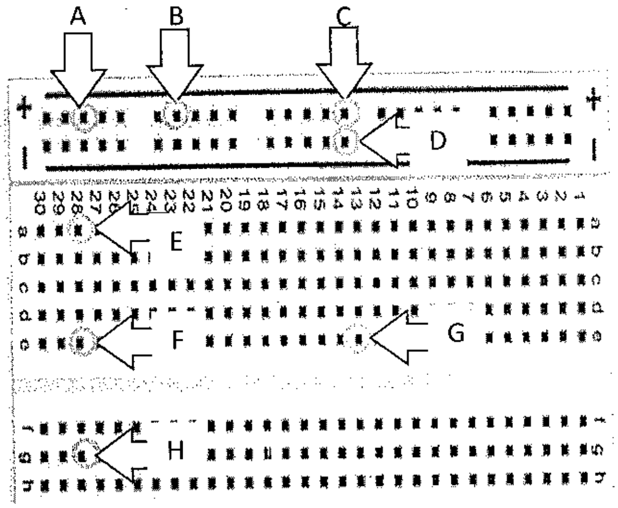
					
A	B	C	D	E	F

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

A B C D E



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	

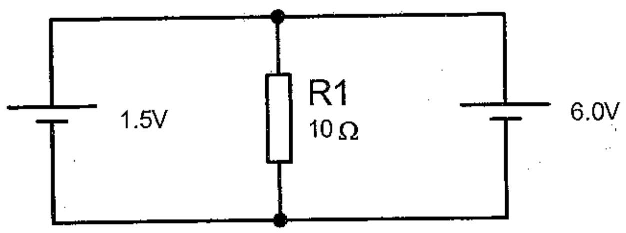
d) Before taking any reading, an oscilloscope needs to be calibrated. Briefly explain the steps in the calibration process.

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 x 10^{7} Ω^{-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)

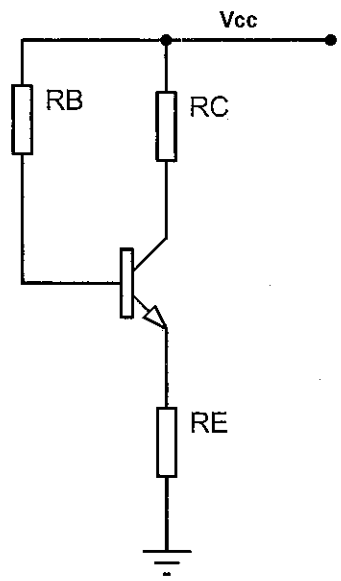


Figure 1

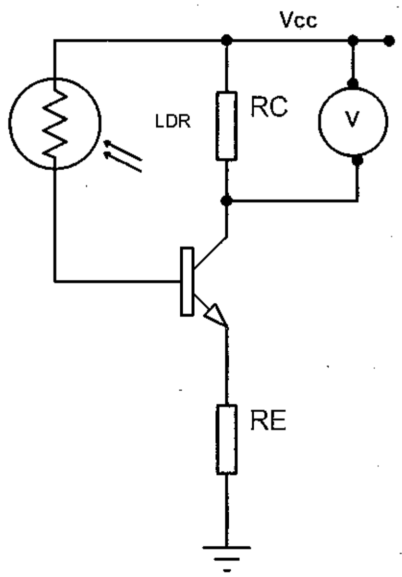


Figure 2

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

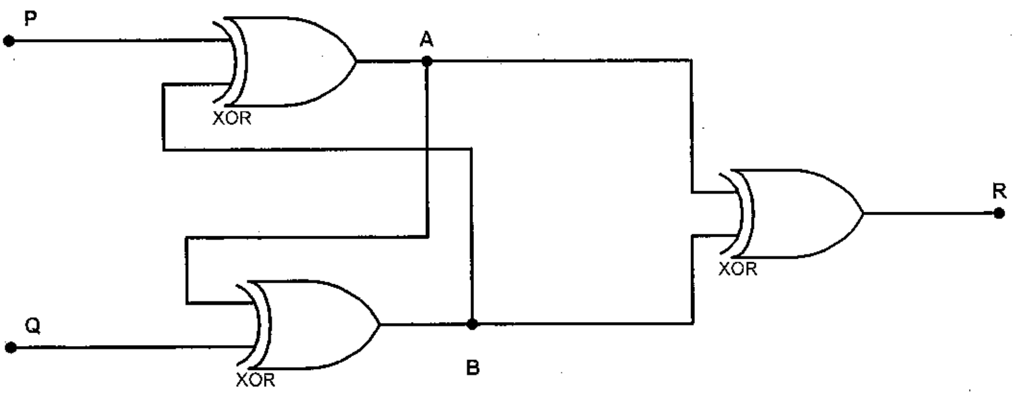
b) Consider the following circuit to find B and R if,

i) P = Q = A = 0

ii) P = Q = 0 ; A = 1

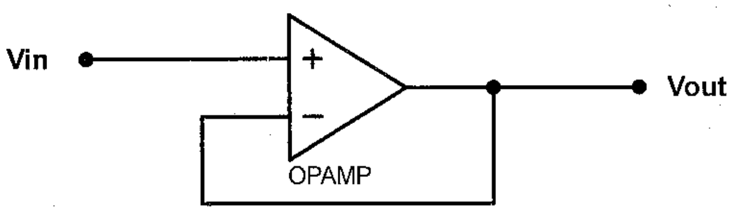
iii) P = Q = A = 1

iv) P =1 and Q = 0



5) Assume all components are ideal

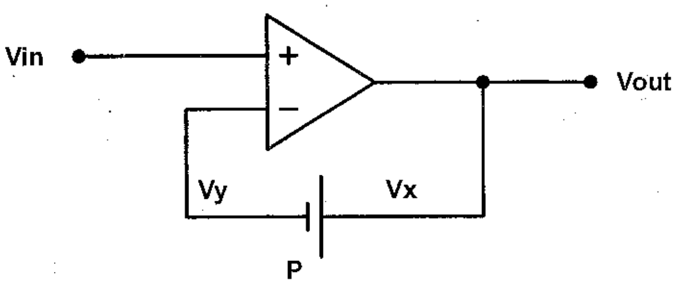
a) Consider the following circuit to obtain an expression for the Vout as a function of Vin



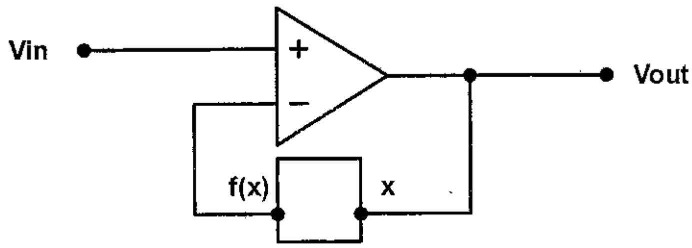
b) Consider the following circuit.

i) If the cell has a voltage of P, Obtain a relationship between Vx and Vy .

ii) Obtain an expression for Vout as a function of Vin

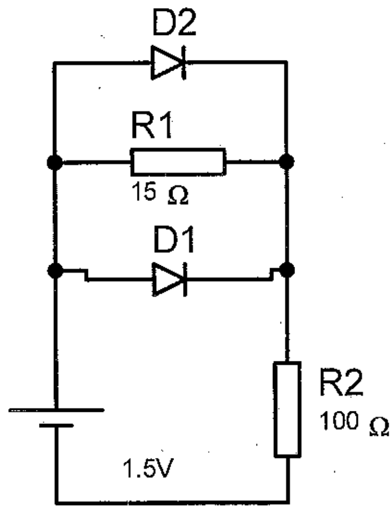


c) Consider the following circuit. A hidden circuit is represented by the square. It will output f(x) voltage when input voltage is x. If $f(x) = x^2$ Obtain an expression for Vout as a function of Vin



6)

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

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