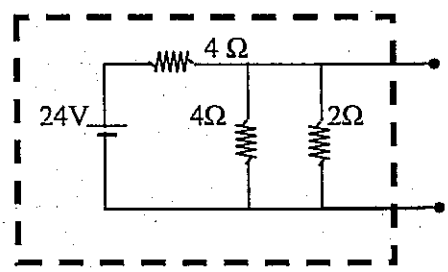
The Open University of Sri Lanka
B.Sc./B.Ed Degree Programme Level-03
Final Examination - 2009/2010
PSU 1143/PCU 1170 - Electronics for Biology Students
Duration : Two and half (2 ½) hours

Date: 23rd December 2009 **Time: 9.30 p.m.- 12.00 noon**

Answer Four(4) questions only

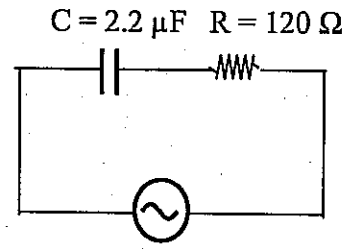
(1) (a) What are the characteristics of an ideal op-amp?
(b) Draw the circuit diagram of an inverting amplifier circuit using an operational amplifier as the main component, and two resistors R_1 and R_2
(c) Write down the two Golden rules for operational amplifiers.
(d) Derive the expression for the voltage gain of an inverting amplifier, in terms of R_1 and R_2 .
(e) A symmetrical square wave voltage signal (minimum : -5 V and maximum : + 5V) is fed to an inverting amplifier circuit which consists of 10 kΩ and 100 kΩ resistors. Sketch the input and output voltage signals on the same voltage-time axis.
(f) The input impedance of an inverting amplifier is lower compared to a non inverting amplifier. Sketch a suitable diagram and explain how you would connect a buffer amplifier to increase the input impedance of the inverting amplifier without changing the original voltage gain.

(2) An LED rated as 3.2 V/ 0.15 W is lighten using a 9 V dc battery.
(a) Find a suitable resistor which can be used to limit the current.
(b) Calculate the energy dissipated by the LED in two minutes.
(c) How many electrons will flow through the LED in the above period?
(d) Draw the Thevenin's equivalent circuit of the following resistor-voltage network.



(e) If a 20 Ω load resistor is connected to the output of the circuit referred in (d) find the current through the load.

(3) A capacitor (C) and a resistor (R) are connected in series with a signal generator, which produces sinusoidal voltage signal in the form of, $I = I_0 \sin(\omega t)$.



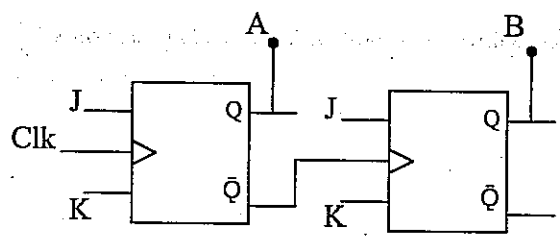
$I = 80 \times 10^{-3} \sin(6.3 \times 10^{-3} t)$ Amp

(a) Find the impedance of each component and hence the total impedance of the above circuit.
(b) Calculate the peak voltage across each component.
(c) Sketch the voltage signal variation across the capacitor and resistor on the same graph.
(d) When the phase of the voltage signal across the capacitor is at 30°, what could be the magnitude of the voltage signal across the capacitor and resistor?

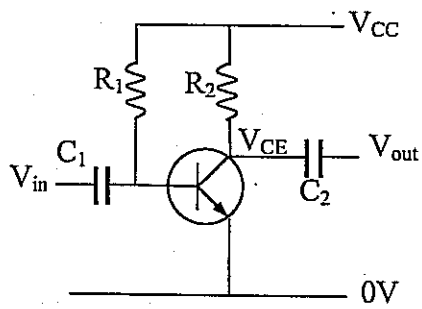
(4) The following truth table shows the logic levels of a combinational logic gate circuit having two inputs(**A** & **B**) and one output (**C**).

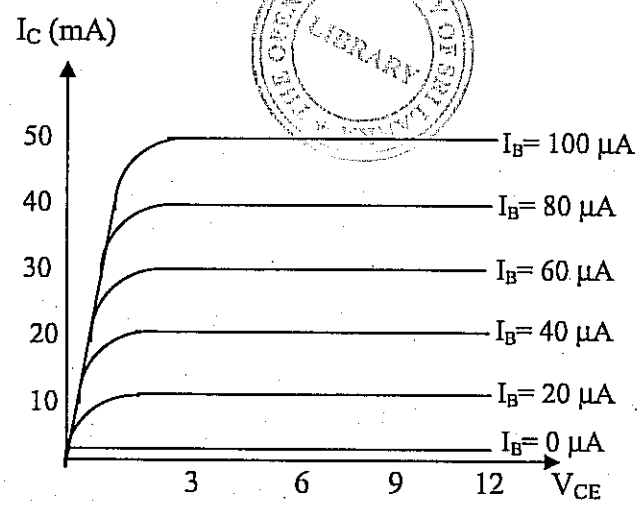
A	B	C
0	0	1
0	1	0
1	0	1
1	1	1

(a) Derive the boolean expression for the above truth table.
(b) Construct the combinaitional logic gate circuit according to the boolean expression that you have written.
(c) Draw the truth table of a JK flip flop.
(d) The following diagram shows the combination of two JK flip flops. Their J and K inputs are maintained at logic state "1". The flip flops are triggered at the rising edge of the clock pulses and the initial states of the A and B output are at logic state "0". Draw the timing diagrams (output voltage variation with time) at outputs A and B for five clock pulses.



(5) The following figure shows the circuit diagram and the output characteristic curves of a common emitter transistor amplifier.
In this circuit, the base-emitter junction is forward biased (V_{BE} = 0.7 V, I_B = 50 μA) and the collector-emitter junction is reverse biased using V_{CC} = 12 V, R_1 and R_2 = 120 kΩ. Then the circuit is ready to amplify V_{in} signals.





(a) Calculate the value of R_1.
(b) To avoid the clipping of negative voltage signal at the output , V_{CE} is maintained at half of the supply voltage (V_{CC}). If current gain (β) is 100, calculate the value of R_2.
(c) Redraw the output characteristic curves on your answer script and colour the cut off region, saturation region and active region.
(d) If V_{in} is a sinusoidal signal with the amplitude of ± 8 mV, draw the V_{in} and V_{out} on the same voltage–time axis. (Consider the factors I_B / V_{BE} = 500 μAV^{-1} and the given β).
(e) Explain the purpose of having C_1 and C_2 in the above circuit.

(6) Write short notes on any **Five** of the followings.
(a) The function of electrolytic capacitors in low voltage dc power supplies
(b) Zener diodes
(c) Basic logic gates
(d) Combinational and sequential logic circuits
(e) Shift registers
(f) N- type and P-type semiconductor materials
(g) Low pass and high pass filter circuits