The Open University of Sri Lanka
B.Sc. Degree Programme -Level 05- 2025/2026
Final Examination
Electronics for Biology Students- PHU5318
Duration : Two (2) hours

Date : 13th January 2026 **Time: 1.30 p.m to 3.30 p.m**

Answer four (4) questions

(1). (A) The power dissipated at a load connected to a source depends on the characteristics of the source and the load .

(i) State the maximum power transfer theorem related to an electrical load connected to a voltage source.

(ii) Show that, the power dissipation of the bulb (P_l) which is connected to a battery is given by

$$P_l = \frac{V^2 R_l}{(R_s + R_l)^2}$$

Where V - voltage of the battery (Electromotive force)
R_l - resistance of the bulb
R_s – internal resistance of the battery

(iii) Using the maximum power theorem , derive the maximum power dissipated through the bulb ;

$$P_{max} = \frac{V^2}{4R_s}$$

(iv) A torch is operated with two 1.5 V batteries each with 1.0 Ω internal resistance. What is the wattage of the bulb that has to be fixed to this torch to get the maximum glow?

(B) An LED rated as 2.8 V/ 0.2 W is lighten with a 12 V dc battery.
(i) Calculate the values of the resistance which should be serially connected to the LED and battery.

(ii) Calculate the energy dissipated by the LED in two minutes.

(iii) How many electrons will flow through the LED in the above period ?
(charge of an electron is 1.6×10^{-19} C)

(2) A circuit consisting of an inductor $L = 80$ mH and a resistor $R = 15\Omega$ connected in series is driven by an ac source with the voltage ; $V(t) = V_0 \sin(\omega t)$,
where V_0 is the peak voltage and ω the angular frequency.
(i) Calculate the total impedance; Z of the above LR circuit, when $\omega = 500\ rad\ s^{-1}$

(ii) Calculate the current amplitude I_0 in the circuit if the peak source voltage is $V_0 = 120$ mV.

(iii) Draw a phasor diagram showing the voltage across the resistor (V_R), the voltage across the inductor (V_L), and the total voltage V_Z. On the same diagram indicate the phase of the total current of the circuit; I.

(iv) Calculate the phase difference; ϕ between the total voltage (V_Z) and the current(I) for the LR circuit (use the *tan* relationship).

(v) If the angular frequency of the source increases gradually from zero to a large value, sketch on a single graph, the magnitude of the impedance of ; the resistor(Z_R), the inductor(Z_L) indicating the gradient of each graph.

(vi) Now connect a 60 μF capacitor (C) in series with the other components in the circuit. On a graph sketch how the magnitude of the total current drawn from the source varies with the frequency. Identify and write down the frequency at which any notable feature occurs .

(3) A certain NPN transistor has a current gain (β) of 120. The forward biased voltage of the transistor is 0.7 V. The transistor is used in the following circuit:

Supply voltage: $V_{CC} = 12$ V
Collector resistor: $R_C = 1.2$ kΩ
Base resistor: R_B is connected from VCC to the base
Emitter is grounded

When designing the circuit, the goal is to set a collector current of 10 mA.

(i) Explain the purpose of the base resistor R_B in the circuit.

(ii) Calculate the base current required to achieve the collector current of 10 mA.

(iii) Find the required value of the base resistor R_B.

(iv) Calculate the collector–emitter voltage V_{CE} when $I_C = 10$ mA.

(v) State whether the transistor is operating in active, saturation, or cutoff region. Justify your answer.

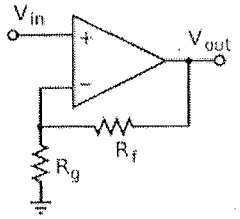
(4).Operational amplifier is a very useful Integrated circuit(Ic) used in electronic circuits.

(i) Write down three input/output characteristics in an **ideal** operational amplifier.

(ii) What are the two golden rules applicable for a closed loop operational amplifier circuits?

(iii) The following figure shows the circuit diagram of a non-inverting amplifier . Using the golden rules , derive the voltage gain ;

$$\frac{V_{out}}{V_{in}} = \left(1 + \frac{V_f}{V_g}\right)$$



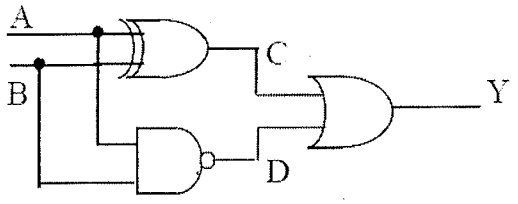
(iv) Suggest reasonable values for R_g and R_f to obtain the voltage gain of +11.

(v) The output voltage of a photodiode is -2 mV. It is connected to the input of the above non-inverting amplifier circuit which has +11 voltage gain. Modify this circuit adding an inverting amplifier circuit to obtain 2.2 V as the output.

(5) (i) Give the truth table of the OR gate , exclusive OR gate & NAND gate.

(ii) Give an example for a practical application of the exclusive OR gate.

(iii) Derive the Boolean expression for the output of the following circuit.



A	B	Y
0	0	
0	1	
1	0	
1	1	

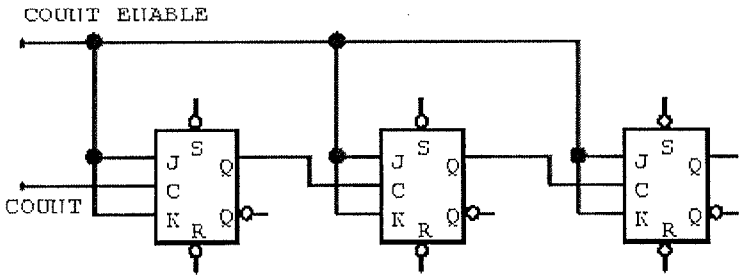
(iv)Complete the above truth table according to the circuit.

(v) Draw the circuit diagram of half adder circuit and explain its operation, taking one bit two numbers.

(6) (i) Explain the difference between combinational and sequential logic circuits.

(ii) Write down the truth table of a J-K Flip flop.

(iii) The following diagram shows a three-bit ripple counter.



If each J-K flip flop activates at the falling edge of the clock pulse, draw the waveform at each binary output ; Qo, Q1 and Q2 for seven clock pulses.

(iv) How do you modify this circuit to reset the output after 4 clock pulses.

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