SIR ARTHUR LEWIS COMMUNITY COLLEGE
ACADEMIC YEAR (2024/2025) – SEMESTER TWO
END OF SEMESTER FINAL EXAMINATION

COURSE CODE : **PHY218**

COURSE TITLE : **Electricity, Electronics and Modern Physics**

LECTURER(S) : **MR CECIL FEVRIER**

DATE : **May 8, 2025**

TIME : **1 p.m.**

DURATION : **2 HOURS**

STUDENT ID # : _____

GENERAL INFORMATION AND INSTRUCTIONS

- Students must sign **IN** and **OUT** on the examination class list.
- Write your ID number on the question paper.
- This paper has seven (7) structured questions, in THREE sections.
- Answer a total of five (5) questions.
- You must answer at least ONE question from each section.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

Instructions: **This paper has seven (7) structured questions, in THREE sections.**

Answer a total of five (5) questions.

You must answer at least ONE question from each section.

Section A

1. (a) (i) Distinguish between a digital system and an analog system. [2]

(ii) Explain one advantage of using digital systems over analog systems. [2]

(b) What logic function is equivalent to two switches connected in series? [1]

(c) The logic circuit in Figure 1 uses four identical logic gates to perform a logic function.

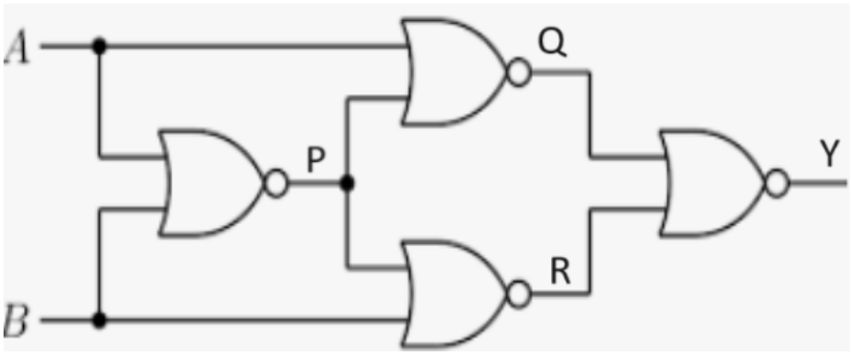

Figure 1

(i) What is the name of the logic gates used in the circuit? [1]
(ii) Draw the truth table for the logic circuit. [4]
(iii) Use the truth table to determine the equivalent gate of the circuit. [2]

2. (a) State THREE characteristics of the ideal operational amplifier and their Implications for the ideal operational amplifier. [3]

(b) What effect does negative feedback have on the gain and bandwidth of an operational amplifier? [2]

(c) Figure 2 shows two circuits A and B cascaded to produce an output, V_O.

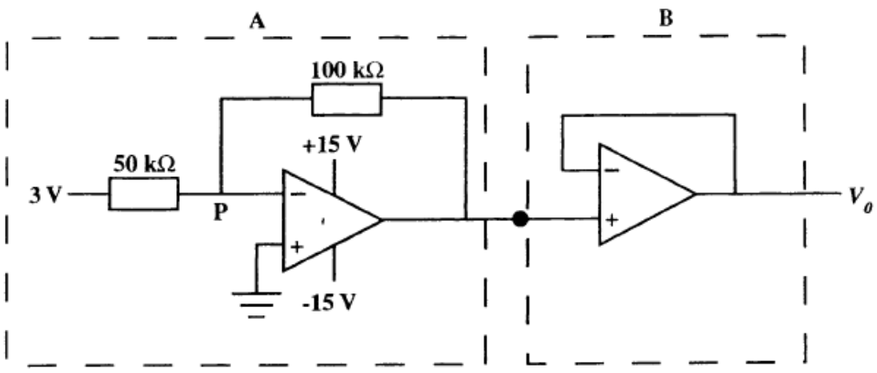

Figure 2

(i) Identify the type of amplifier used in circuit A and circuit B. [2]
(ii) Determine the output voltage, V_O, of the circuit. [4]
(iii) Suggest a practical use for circuit B. [1]

3. (a) What are the main characteristics of an operational amplifier (OP AMP)? [2]

(b) Op amps are widely used in electronics to perform a number of functions. They are often used as inverting amplifiers and non-inverting amplifiers.

(i) Identify one feature that the two amplifier circuits have in common. [1]

(ii) Determine the output voltage of the circuit shown in Figure 2 (a) for a sinusoidal input of 2.5 mV

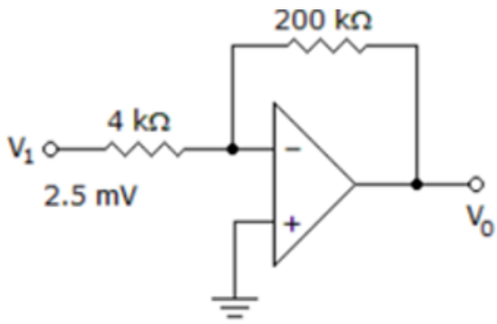

Figure 2 (a) [4]

(c) A comparator circuit shown in Figure 2 (b) below is used to indicate temperature change.

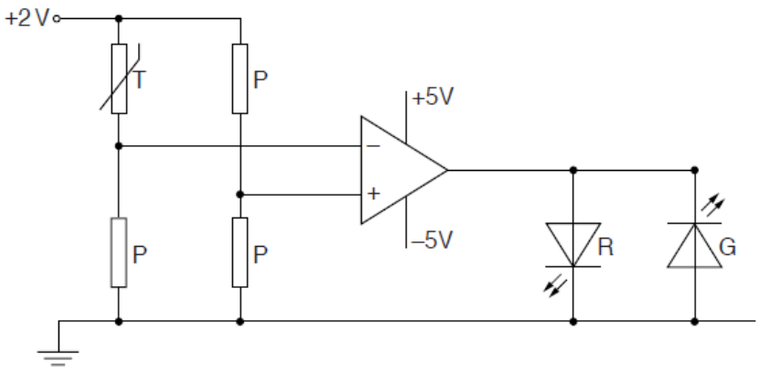

Figure 2 (b)

The resistance of the thermistor T is 2100 Ω at 16 °C and 1900 Ω at 18 °C, Each resistor P has a resistance of 2000 Ω.

(i) Find the potential at the non-inverting terminal of the op-amp. [1]

(ii) Find the potential at the inverting terminal when the temperature is 16 °C. [2]

(iii) Use your answers from (i) and (ii) to determine which LED would be on at 16 °C. [2]

SECTION B

4. Figure 3 shows how an alternating current changes with time.

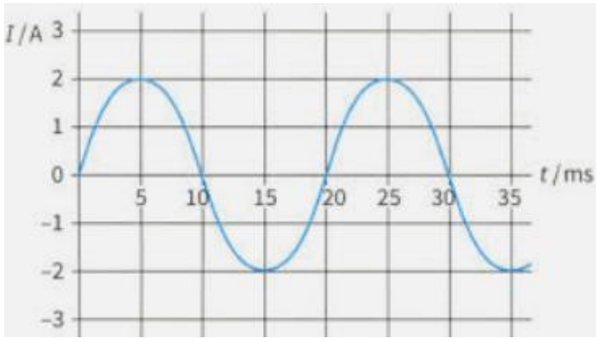

Figure 3

(a) Find: (i) the peak to peak current, [2]
(ii) the r.m.s. current, [2]
(iii) the frequency of the current. [2]

(b) In Figure 5, the battery's e.m.f. is 24.0 V, the total resistance is 2.0 kΩ and the capacitance is 15 μF.

(i) What is the time constant of the circuit? [2]

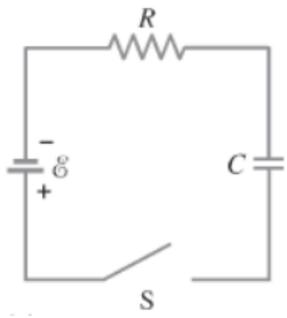

Figure 5

(ii) Calculate the time it would take for the voltage across the resistor to fall to 12.0 V. [4]

5. (a) State Gauss' Law in words and write its mathematical form. Explain the physical significance of each term in the equation. [4]

(b) A uniformly charged solid sphere of radius R carries a total charge Q.Use Gauss' Law to derive the electric field at a distance r from the center of the sphere, where:
(i) $r < R$ (inside the sphere), [4]
(ii) $r \geq R$ (outside the sphere). [4]

SECTION C

6. (a) What are the two postulates in Einstein's Special Theory of Relativity? [4]

(b) What is meant by a proper length in terms of special relativity theory? [2]

(c) A spaceship 100 m long and 30 m wide travels past the Earth at a speed of 0.95 c. What would be the length and width of the spaceship as measured by an observer on Earth? [4]

(d) Find the rest energy of a proton, given that its mass is 1.67×10^{-27} kg. [2]

7. (a) Explain briefly Bohr's model of the hydrogen atom. [3]

(b) Briefly describe and explain the formation of the emission spectra of hydrogen. [3]

(c) Outline the two main differences between the Lymann and Balmer series in the hydrogen emission spectrum. [2]

(d) The energy level of electrons in the ground state (n =1) of hydrogen gas is − 13.6 eV. How much energy is released when an electron moves from energy level 4 to energy level 2? [4]

END OF EXAMINATION