Daffodil International University
Department of Electrical and Electronic Engineering, Faculty of Engineering
Mid Term Examination, Spring 2026

Course Code: 0714- 221	Course Title: Electronics II	Teacher's Initial: SR
Section: All	Level-Term: L2-T2	Time: 1.5 Hours
Full Marks: 25	Date: Feb. 23, 2026	

[Notes: Answer all the following questions]

Q1. Determine the output voltage v_o in the Op-Amp circuit of below *Fig. 1.* **CO-1 (C3) 05**

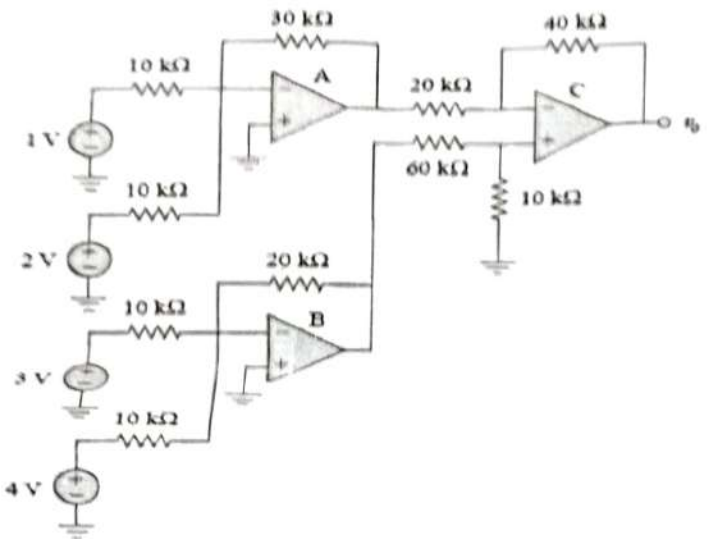

Fig. 1

Q2. A smoke detection system is required to activate an alarm when the smoke concentration in air exceeds a specified safe limit. **CO-1 (C5) 05**

Given:

- Smoke sensor: **MQ-2**
- The sensor provides an analog output of **0–5 V** (Clean air < 1 V, Heavy smoke > 2.8 V)
- In clean air, the output voltage is approximately **0.8 V**
- At the maximum safe smoke level, the sensor output is **2.8 V**
- The alarm should trigger when the sensor voltage exceeds **2.8 V**
- Op-amp used: **LM741**
- The op-amp is powered with **±12 V**
- The sensor output is connected to the **non-inverting (+) input**
- A resistor voltage divider (each resistor ≥ 10 kΩ) from the +12 V supply is to be used to generate the reference voltage

Tasks:

1. Draw the complete comparator circuit using LM741 for the smoke detection system.
2. Determine the required reference voltage for triggering the alarm.
3. Design the resistor voltage divider network (choose suitable resistor values ≥ 10 kΩ).
4. Determine the output voltage of the op-amp when:
   - (a) Sensor output = 2.0 V
   - (b) Sensor output = 3.2 V
5. Indicate clearly whether the alarm is ON or OFF in each case.

Q3 I. A differential amplifier produces an output of 8 V when a differential input of 20 mV is applied. When the same voltage (20 mV) is applied to both inputs simultaneously (common-mode input), the output is 4 mV. **CO-1 (C3)** **02**

- Determine the differential gain A_d
- Determine the common-mode gain A_{cm}
- Calculate the CMRR in dB

II. **Design** a subtractor circuit using two Op-Amp. All resistances must be $\geq 10k\Omega$ in your design. **03**

Q4. Design an Op-Amp Circuit such that $v_0 = 10v_s + 2\int v_s dt$, Where v_s and v_0 are the input voltage and output voltage respectively. **CO-1 (C3)** **05**

Q5. A comparator in the below *Fig. 2* is designed using an LM741 op-amp with ± 9 V supply. The input is a sine wave: $V_{in} = 5\sin(2\pi * 10kHz * t)\, volt$. The op-amp is configured as a comparator (open-loop) with no feedback resistor. The LM741 has a typical **slew rate** of 0.5 V/µs. Assume infinite gain of the op-amp. **CO-1 (C3)** **05**

- Draw the expected input and output waveforms of the below comparator assuming the op-amp is ideal (infinite slew rate).
- Now consider the real LM741 with slew rate = 0.5 V/µs. Calculate the minimum transition time (rise/fall time) for the output swing. Sketch the actual (non-ideal) output waveform of the comparator circuit considering the finite slew rate. Clearly show how the output edges appear sloped instead of perfectly vertical.

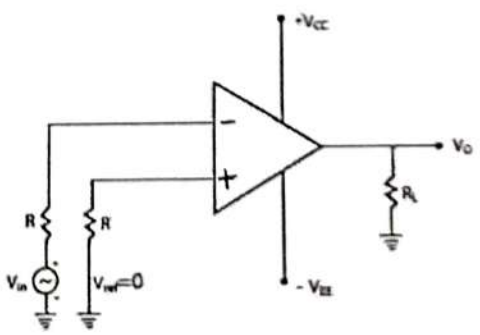

Fig. 2: OP-Amp Comparator