GENERAL CERTIFICATE OF EDUCATION BOARD
Technical and Vocational Education Examination

Electronic Systems 2
5260

Duration: Three Hours (3hrs)

Answer question One and any Three Questions.

Show all the steps in your calculations giving your answer at each stage and indicating the units and symbols used.

All sketches must be neat and clear.

You are allowed to use non programmable calculators

You are reminded of the necessity for good English and orderly presentation in your answers.

THEME: MONITORING THE CHANGE IN VISCOSITY OF OIL IN A VEHICLE

The device uses electronics to monitor the change in viscosity of oil in a vehicle. Generally, the changes in viscosity of the oil is observed after the car must have covered a given number of kilometres. The user observed that the device no longer operates as required. He then seeks your expertise to eliminate the problem. This equipment whose circuit diagram is represented in figure 1 on page 7 contains amongst other electronic functions those of power supply, timing circuit, counting, interfacing and display circuits. In your capacity as a qualified electronic technician, you have been charged to carry out repairs on this equipment. Extract of some technical documents, represented on page 6, have equally been placed at your disposal to facilitate your task. Carefully exploit these documents and answer the questions in the following two sections.

1. **Power supply**

   Figure 2 shows the circuit diagram of the power supply used in this system.

   1.1 Identify the type of power supply used in this system. (2 marks)

   1.2 Give two advantages of this type of power supply. (2 marks)

   1.3 Calculate the full load primary and secondary current of the transformer used in this power supply. (2 marks)

   1.4 Give three criteria used to choose a transformer. (3 marks)

   1.5 Give the role of the component labelled "BRIDGE". (1 mark)

   1.6 Give the role of each of the following capacitors:
   - C1 (1 mark)
   - C2 (1 mark)
   - C3 (1 mark)

   1.7 If the colour codes of the resistor labelled R1 are Brown, Black, Red and Silver, give the resistance rating of the resistor. (2 marks)

   1.8 Give the role of each of the diodes D1 and D2. (2 marks)

   1.9 If the drop out voltage of the integrated regulator is 2V, calculate the minimum voltage required at the input of the integrated regulator. (3 marks)

   1.10 Deduce from the table 1 the rating of the battery. (2 marks)

   1.11 It was observed that the supply from ENEO is on but the device is not powered. Use flow chart to troubleshoot and repair the system. (3 marks)
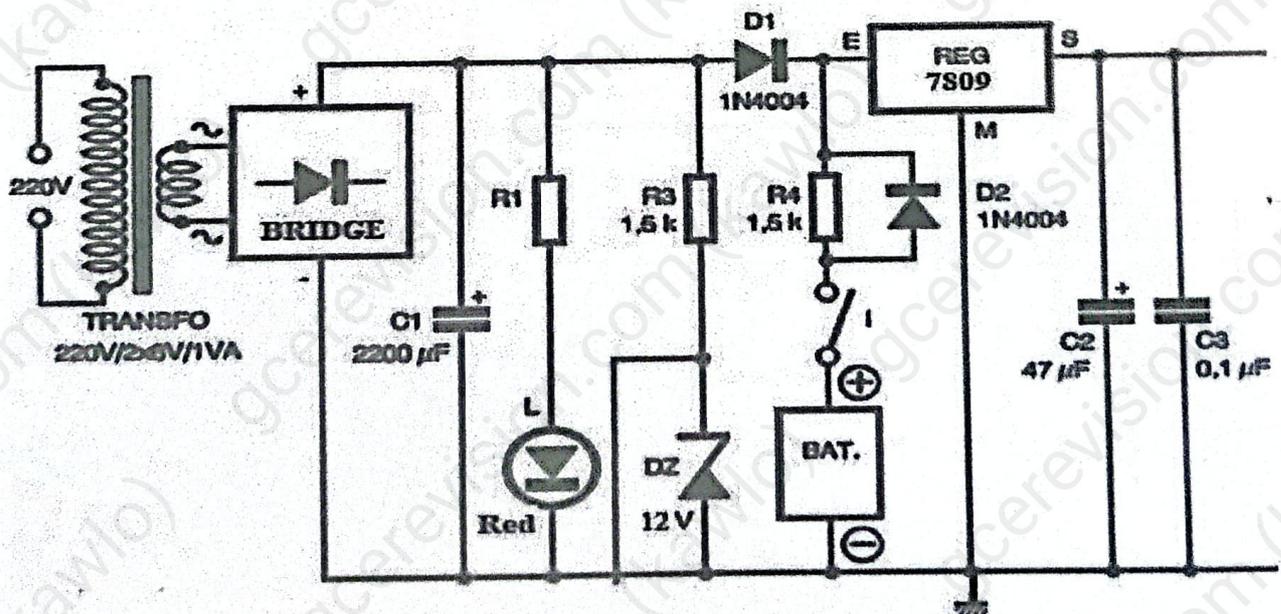
(Total = 25 marks)

2. **Collection of signal, amplification and wave shaping**

The signal, collected by the high voltage coil (HV coil), is transmitted to the amplifier circuits

2.1 Amplifier circuits

2.1.1   Give the role of the diode labelled D3.   **(1 mark)**

2.1.2   Calculate the voltage obtained at the non-inverting input V_{c+} of the operational amplifier.   **(2 marks)**

2.1.3   What is the operating mode of the operational amplifier?   **(1 mark)**

2.1.4   Give three characteristics of an ideal operational amplifier.   **(3 marks)**

2.1.5   Calculate the maximum voltage gain of the operational amplifier.   **(2 marks)**

2.1.6   The output of the operational amplifier is used to drive a transistor amplifier.

    2.1.6.1   What type of transistor amplifier configuration is implemented in this amplifier circuit?   **(2 marks)**

    2.1.6.2   It has been observed that the voltage gain of this transistor amplifier is approximately one. What is the role of this amplifier stage?   **(1 mark)**

    2.1.6.3   What is the role of the resistor labelled R17?   **(1 mark)**

2.2 Wave shaping

The output from the transistor amplifier is used to drive the wave shaping circuit.

2.2.1   Give the name of the circuit built with NOR III and IV of IC2, C11 and R7.   **(2 marks)**

2.2.2   Copy and complete the wave forms below.   **(4 marks)**
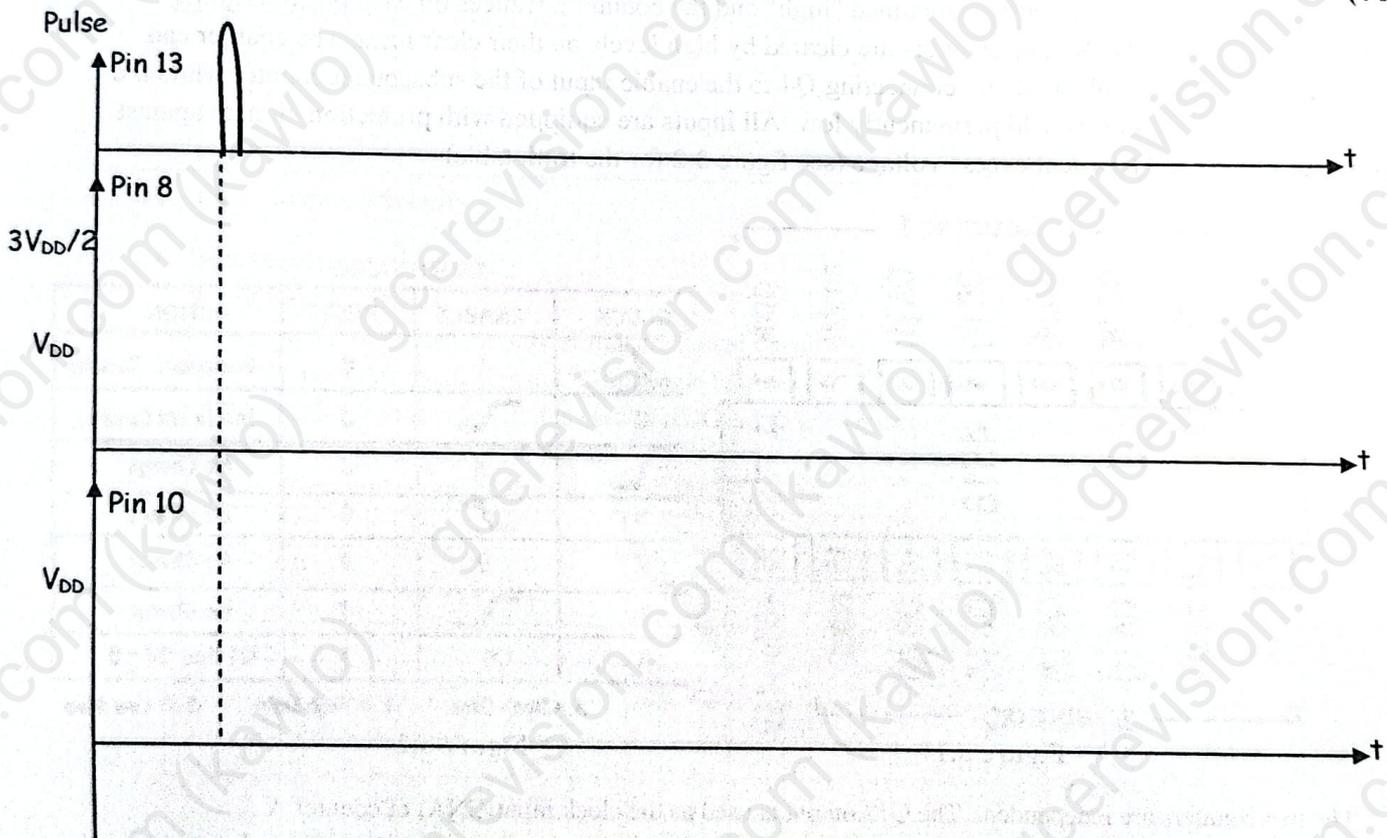
2.2.3   Calculate the pulse width Tp of the signal produced at pin 10.   **(2 marks)**

2.2.4   Give the name of the circuit built with NOR I and II of IC2, R8 and R19.   **(2 marks)**

2.2.5   Give the role of each of the components labelled R9 and C13.   **(2 marks)**

(Total = 25 marks)

3. Counter and resetting of the counter circuits

3.1 Frequency divider circuit

It is designed with IC4 and IC5. These integrated circuits are of the CMOS family with reference 4040BC. CD4040BC is a 12-stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to the zero state by a logical "1" at the reset input independent of clock. The output from the wave shaping circuit is used to drive the frequency divider circuits. The frequency at any of the outputs is given as

$$f_{Q_n} = \frac{Input\ frequency}{2^{n-1}} \ .;\ \text{where n is the flip flop number.}$$

3.1.1 Give two advantages of the CMOS logic family over TTL logic family. (2 marks)

3.1.2 If the input frequency from the wave shaping circuit is 20MHz, calculate the frequency at the Q12 output of IC4. (3 marks)

3.1.3 Deduce the frequency at the Q12 output of IC5. (2 marks)

3.2 Counter

It is designed with IC6; it is a dual BCD counter. It consist of two identical internally synchronous 4-stage counters. The counter stages are D-TYPE flip-flops having interchangeable CLOCK and ENABLE inputs for incrementing on either the positive-going or negative-going transition. For single-unit operation the ENABLE input is maintained "high" and the counter advances on each positive-going transition of the CLOCK. The counters are cleared by high levels on their clear lines. The counter can be cascaded in the ripple mode by connecting Q4 to the enable input of the subsequent counter while the clock input of the latter is held permanently low. All inputs are equipped with protection circuits against static discharge and transient excess voltage (see figure 3.2 for the truth table)
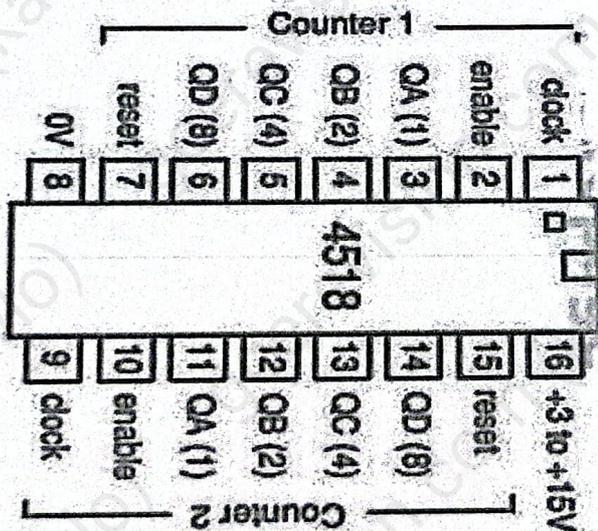

Figure 3.1

TRUTH TABLE

CLOCK	ENABLE	RESET	ACTION
⌐	1	0	Increment Counter
0	⌐	0	Increment Counter
⌐	X	0	No Change
X	⌐	0	No Change
⌐	0	0	No Change
1	⌐	0	No Change
X	X	1	Q1 thru Q4 = 0

X = Don't Care   1 ≡ High State   0 ≡ Low State

Figure 3.2

The two counters are independent. The Q12 output is used as the clock input(ENA) of counter A of IC6. The clock input(ENB) of counter B is active when the following outputs are active: Q9 and Q11 of IC4; Q2, Q5, Q9 and Q10 of IC5; Q1A of IC6.

3.2.1 Determine the number of counts required to activate a count in counter B of IC6. (2 marks)

3.2.2 If the input frequency is 20MHz, calculate the frequency of the clock signal of counter B. (2 marks)

Copy and complete the truth table of counter B below.

(6 marks)

Number of clock pulses	Outputs				Decimal count
	Q4B	Q3B	Q2B	Q1B	
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

3.2.3   Deduce the mode number of the counter.

(2 marks)

3.2.4   If the input frequency to this counter is 1Hz, calculate the output frequency.

(2 marks)

3.2.5   Give the state of the diodes D12 and D13 when the push button BP is
- Active
- inactive

(2 marks)

(2 marks)

(Total = 25 marks)

4.   Decoder – display circuits

4.1   Decoder circuit

It is designed with IC7

4.1.1   What is the logic family of this integrated circuit?

(2 marks)

4.1.2   Give three characteristics of this logic family.

(3 marks)

4.1.3   Is the decoder used in this system a BCD – to – 7 segment decoder or a BCD to decimal decoder? Explain your answer.

(3 marks)

4.1.4   Copy and complete the truth table of the decoder.

(8 marks)

D	C	B	A	a	b	c	d	e	f	g
0	0	0	0							
0	0	0	1							
0	0	1	0							
0	0	1	1							
0	1	0	0							
0	1	0	1							
0	1	1	0							
0	1	1	1							
1	0	0	0							
1	0	0	1							
1	0	1	0							
1	0	1	1							
1	1	0	0							
1	1	0	1							
1	1	1	0							
1	1	1	1							

4.2   Display circuit

4.2.1   The display used in this system ids MAN74. Is MAN 74 an LCD or a LED display? Explain your answer.

(3 marks)

4.2.2 Give two advantages that LCD has over LED display. **(2 marks)**

4.2.3 What is the maximum count of this display? (2 marks)

4.2.4 Give the role of the resistors labelled R21 to R27. (2 marks)

(Total = 25 marks)

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5. The monitoring of the change in viscosity of oil in a car can sometimes be designed with a programmable controlled system like a computer.

5.1 Differentiate between each of the following:
- Series and parallel transmission (2 marks)
- Synchronous and asynchronous transmission modes (2 marks)

5.2 Copy and complete the table below. (6 marks)

S/N	Transmission media	Used for
1	Optical fibre	
2	Coaxial	
3	Unshielded twisted pair	

5.3 Give the full meaning of the following acronyms
- RAM (2 marks)
- ROM (2 marks)
- BIOS (2 marks)

5.4 Name two types of RAM. (2 marks)

5.5 Name two types of mother board form factor. (2 marks)

5.6 Name two examples of input devices (2 marks)

5.7 Give three functions of the operating system. (3 marks)

(Total = 25 marks)

Physical Specifications of Common Cells

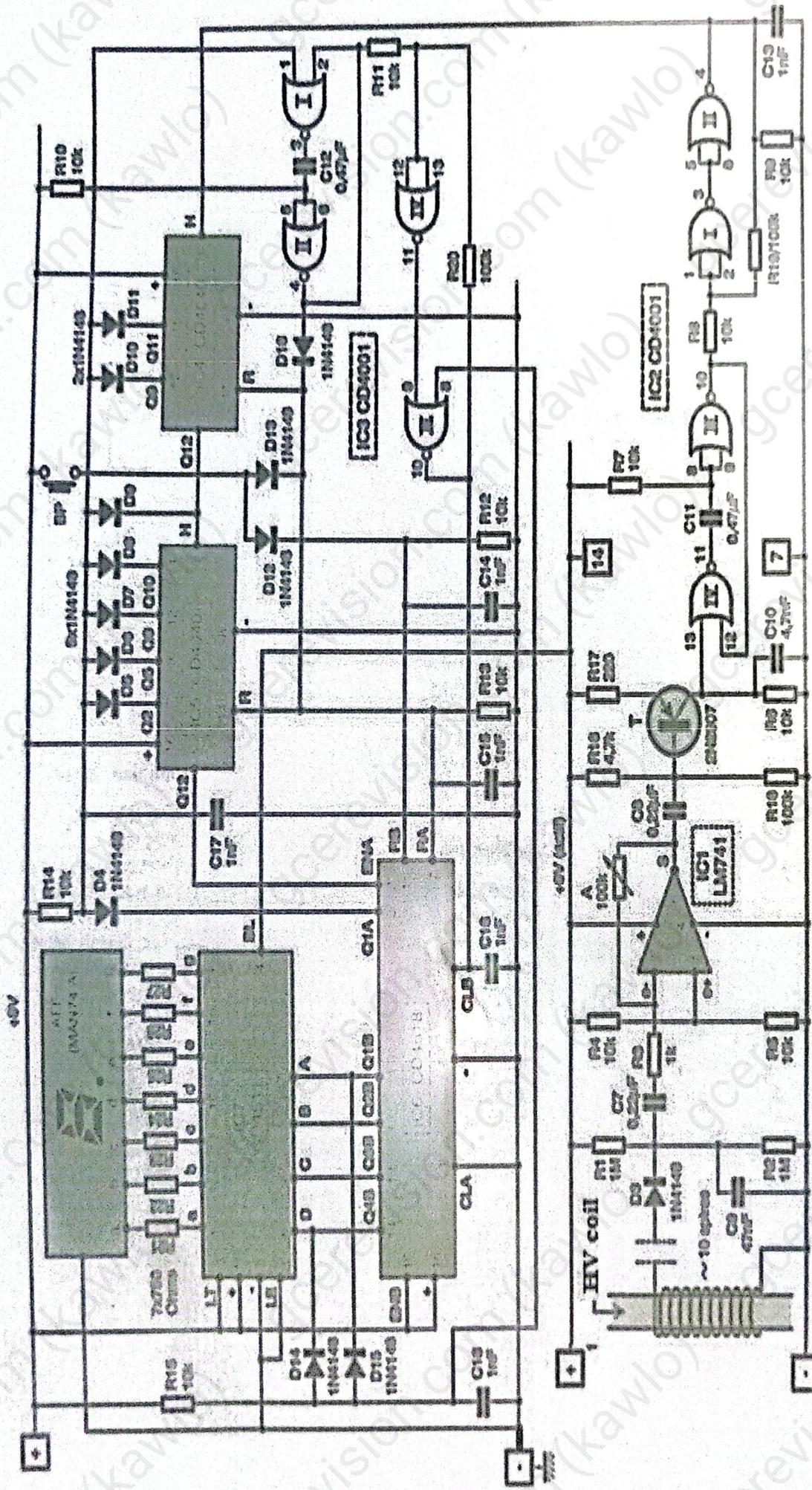| Type	Size	Dimension(in)	weight	Voltage rating
Carbon Zinc	D	1.34 x 2.42	3.07	1.5
NiCad	AA	0.57 x 1.99	0.85	1.25
Zinc Chloride	AAA	0.41 x 1.75	0.32	1.5
Alkaline	AAA	0.41 x 1.75	0.40	1.5
Alkaline	9V	1.03 x 1.94 x .69	1.59	9.0
NiCad	9V	1.03 x 1.94 x .69	1.25	9.0
Lead Acid	12V	Variable	variable	12

Table 1: Specifications of common cells.

Figure 1 : Circuit diagram of monitoring of oil changes in a vehicle