T740(E)(M28)T
APRIL EXAMINATION
NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N2
(8080602)
28 March 2013 (X-Paper)
09:00–12:00

This question paper consists of 5 pages, a 1-page diagram sheet and a 3-page formula sheet.
INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. Number the answers according to the numbering system used in this question paper.

4. Keep subsections of questions together.

5. RULE OFF on completion of each question.

6. Use ONLY IEC symbols and units when answering the question paper.

7. ALL sketches must be neat and labelled, using a pencil and a ruler (NOT freehand sketches).

8. NO red or green ink may be used.

9. Use \( \pi \) as 3.142 and NOT as \( \frac{22}{7} \).

10. Write neatly and legibly.
QUESTION 1

Define the following terms:

1.1 Matter
1.2 Conductor
1.3 Covalent bond
1.4 Resonance
1.5 Thermistor

(5 x 2) [10]

QUESTION 2

Refer to FIGURE 1 (on the attached DIAGRAM SHEET) and calculate the following:

2.1 The value of the resistor R1 (2)
2.2 The power consumed by the resistor R2 (2)
2.3 The total resistance of the circuit (6) [10]

QUESTION 3

Refer to FIGURE 2 (on the attached DIAGRAM SHEET) and calculate the following:

3.1 The value of the capacitor (2)
3.2 The value of the inductor (2)
3.3 The total impedance of the circuit (3)
3.4 The total current (2)
3.5 The voltage drop across the capacitor (2)
3.6 The phase angle (3) [14]
QUESTION 4

4.1 An alternating current waveform has a peak-to-peak value of 300 V.

Calculate the following:

4.1.1 The maximum or peak value for voltage (2)
4.1.2 The average and RMS values (2)
4.1.3 The form and crest factors (2)

4.2 The equation for a certain alternating wave is given by the formula:

\[ e = 150 \sin 3.41 t \text{ V.} \]

Use the formula to calculate the following:

The instantaneous value of the voltage 6 and 12 milliseconds after zero. (6)

QUESTION 5

5.1 Draw the symbols of the following diodes and give ONE use of each:

5.1.1 Zener diode (2)
5.1.2 Varactor diode (2)

5.2 Draw and label the expected input and output waveforms of the rectifier in FIGURE 3 (attached DIAGRAM SHEET). The transformer is connected to 220 V/50 Hz. (6)

QUESTION 6

6.1 An ammeter can measure 500 mA full scales. The meter movement requires a current of 1 mA to show a full-scale deflection. The internal resistance of the meter is 500 Ω.

6.1.1 Calculate the shunt resistance (up to THREE decimal points). (3)
6.1.2 Draw and label the circuit of the ammeter described in QUESTION 6.1. (5)

6.2 State THREE precautions which must be taken when measuring current with an ammeter. (3)
QUESTION 7

With reference to the theory of TRANSISTORS, answer the following questions:

7.1 Draw a labelled circuit symbol for an NPN and a PNP transistor. (6)

7.2 Name THREE types of amplifiers. [9]

QUESTION 8

8.1 Define a transducer. (2)

8.2 Discuss the operating principle of the following transducers:
   8.2.1 Thermistor (2)
   8.2.2 Bimetal strip (2)

8.3 Calculate the gain of an amplifier that produces a voltage of 10 V over a 15 Ω loudspeaker when a current of 12 mA is applied to the input. The input impedance of the amplifier is 10 000 ohms. (6)

QUESTION 9

9.1 Define Lenz's law. (3)

9.2 Make a neat labelled sketch of a synchro system showing the connections for the transmitter and receiver to turn in the same direction. (6)

9.3 State THREE advantages of a synchro system over a mechanical system. [12]

TOTAL: 100
FIGURE 1

FIGURE 2

100 V/50 Hz

FIGURE 3

Transformer
220 V/50 Hz
INDUSTRIAL ELECTRONICS N2

FORMULA SHEET

DC THEORY

(i) \[ V = I \times R \]
(ii) \[ R_T = R_1 + R_2 \]
(iii) \[ \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \]
(iv) \[ P = V \times I \]
(v) \[ P = I^2 \times R \]
(vi) \[ P = \frac{V^2}{R} \]

AC THEORY

(i) \[ i = \frac{1}{f} \]
(ii) \[ e = E_m \sin 2\pi ft \]
(iii) \[ i = I_m \sin 2\pi ft \]
(iv) \[ \theta = 2\pi ft \]
(v) \[ I_{AVE} = \frac{I_1 + I_2 + I_3}{n} \]
(vi) \[ I_{RMS} = \sqrt{\frac{I_1^2 + I_2^2 + I_3^2}{n}} \]
(vii) \[ V_{AVE} = \frac{V_1 + V_2 + V_3}{n} \]
(viii) \[ V_{RMS} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2}{n}} \]
(ix) \[ V_{AVE} = V_M \times 0.637 \]
(x) \[ V_{RMS} = V_M \times 0.707 \]
(xi) Form factor = \[ \frac{RMS \text{ value}}{AVE \text{ value}} \]
(xii) \( \text{Crest factor} = \frac{\text{Maximum value}}{\text{RMS value}} \)

(xiii) \( \omega = 2\pi f \)

(xiv) \( X_C = \frac{1}{2\pi f C} \)

(xv) \( X_L = 2\pi f L \)

(xvi) \( V_T = \sqrt{V_R^2 + V_L^2} \)

(xvii) \( V_T = \sqrt{V_R^2 + V_C^2} \)

(xviii) \( V_T = \sqrt{V_R^2 + (V_L \approx V_C)^2} \)

(xix) \( Z = \sqrt{R^2 + X_C^2} \)

(xx) \( Z = \sqrt{R^2 + X_L^2} \)

(xxi) \( Z = \sqrt{R^2 + (X_L \approx X_C)^2} \)

(xxii) \( I_T = \frac{V_T}{Z} \)

(xxiii) \( V_C = I_T \times X_C \)

(xxiv) \( V_R = I_T \times R \)

(xxv) \( V_L = I_T \times X_L \)

(xxvi) \( \theta = \cos^{-1} \frac{R}{Z} \)

(xxvii) \( f_0 = \frac{1}{2\pi \sqrt{LC}} \)

MEASURING INSTRUMENTS

(i) \( R_{SH} = \frac{I_M \times R_M}{I_{SH}} \)

(ii) \( R_S = \frac{V_T}{I_M} - R_M \)

TRANSISTORS

(iii) \( I_c = I_c + I_b \)
DECIBEL RATIOS

(iv) \[ N = 10 \log \frac{P_0}{P_1} \]

(v) \[ N = 20 \log \frac{I_0}{I_1} + 10 \log \frac{R_0}{R_1} \]

(vi) \[ N = 20 \log \frac{V_0}{V_1} + 10 \log \frac{R_1}{R_0} \]

If \( R_1 = R_0 \)

(vii) then \( N = 20 \log \frac{I_0}{I_1} \)

(viii) \[ N = 20 \log \frac{V_0}{V_1} \]

(ix) RESISTANCE

\[ R = \frac{p\ell}{a} \]

(x) \[ a = \frac{\pi d^2}{4} \]