higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N6

(8080186)

2 August (X-Paper)
09:00 – 12:00

This question paper consists of 6 pages and a 3-page formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers correctly according to the numbering system used in this question paper.
4. ALL the steps of calculations MUST be shown.
5. Label ALL circuit diagrams.
6. Rule off across the page on completion of each question.
7. Write neatly and legibly.

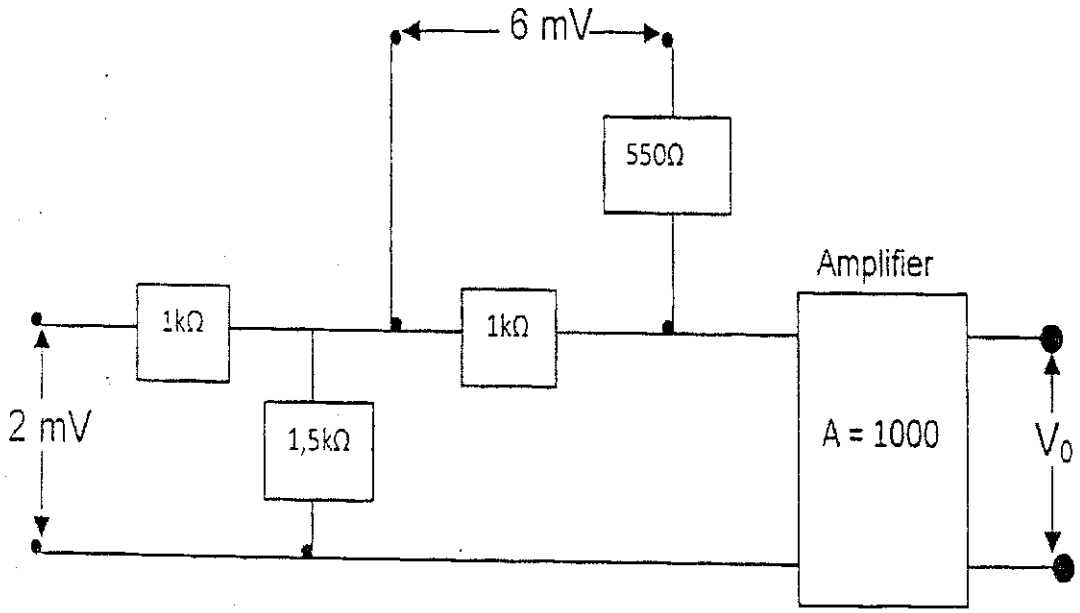
QUESTION 1: TRANSIENTS AND TRANSDUCERS

1.1 A series circuit consisting of a 47 µF capacitor and a 1k2 resistor is supplied with a square-wave pulse train centrally clamped at zero having a peak value of 10 V. Draw ONE cycle of the current transient, should the input frequency be 50 Hz and show ALL the calculations. Assume the capacitor to be discharged initially. (9)

1.2 What do you understand by the term *ringing*? Name the desirable and undesirable effects it has on power circuits. (4)

1.3 When data is being combined to generate a 1 V to 5 V output signal, the output from two voltage tranducers may be too great suggesting that the input signals to the amplifier should be attenuated before the signals are applied to the amplifier.

Calculate the ouput voltage of the amplifier which makes use of the following attenuating network:



(4)

1.4 What exactly is the function of the buffer amplifier when current to voltage interfacing is being used? (3)

1.5 Briefly explain the purpose of a comparator. (3)
[23]

QUESTION 2: ULTRASONIC, X-RAYS AND RADIO-ACTIVITY

2.1 Briefly explain, with the aid of a fully labelled block diagram, the principle of operation of the ultrasonic welding process. Also state the advantage when using this technique. (8)

2.2 The formula to calculate the anode voltage of an x-ray tube is given by:

$$E = \frac{hc}{\lambda q}$$

State what each symbol represents, including values and units. (4)

2.3 A certain photomultiplier tube has a cathode sensitivity of 20 µA/lumen with a maximum safe output current rated at 2 mA. The tube consists of 8 stages, each with an emission factor of 4, having an applied voltage of 100 V per stage.

Calculate the following:

2.3.1 The amplification (2)
2.3.2 Tube sensitivity (2)
2.3.3 Maximum safe illumination (2)
2.3.4 The minimum rating of the voltage source required (2)
[20]

QUESTION 3: AUTOMATIC INSPECTION, TESTING, NDT AND ELECTRONIC SAFETY DEVICES

3.1 Why are ultrasonic techniques used in non-destructive testing (NDT)? (1)

3.2 One method of thickness gauging makes use of matching the wavelength of the ultrasonic energy to the length of the propagation path, resulting in a resonant condition. Name the method described above and draw a fully labelled block diagram satisfying the above description. (4)

3.3 3.3.1 Draw the circuit diagram of an electronic safety protection device where opto-electronics are used in a smoke detector unit. (5)

3.3.2 Briefly explain the principle of operation of the safety device in QUESTION 3.3.1. (3)

3.4 State the advantages and disadvantages of employing the Zener barrier technique in series-shunt protection, when compared to other techniques. (2)
[15]

5.2 A local vehicle assembly company has decided to upgrade its existing control process from conventional relay control to PLC control. As the electronic technician in the company, you have been instructed to write a program using ladder diagram logic, to perform the following task:

A conveyor belt must start up two seconds after it has been activated and automatically stop fifty-nine minutes later. However, you must be able to stop the conveyor belt at any time, should an emergency arise after it has been activated before the same procedure can be repeated.

You may use the following elements:

Normally open contacts
Normally closed contacts
Output coils/timers
Internal relays
End statements

(8)
[14]

TOTAL: 100

$A = B \cdot \left(1 - e^{-t/\tau}\right)$

$A = B \cdot e^{-t/\tau}$

A = Instantaneous value and

B = Maximum value

$V = E \cdot \left(1 - 2e^{-t/\tau}\right) = I \cdot R$ *volts*

$V_D = V_S\left(\frac{R_1}{R_1 + R_2} - \frac{R_3}{R_3 + R_{TH}}\right)$ *volts*

$V_i = \frac{I_L \cdot R_1 \cdot R_D}{R_2} = -\frac{V_o \cdot R_1}{R_2} = \frac{V_o \cdot R_M}{R_M + R_f}$ *volts*

$V_o = -RC \cdot \frac{dV_i(t)}{dt} = -\frac{1}{RC}\int V_i(t)\,dt + V_C(0)$ *volts*

$V_o = \frac{R_2 R_D I_i}{R_1} = -\left[\frac{V_1 R_f}{R_1} + \frac{V_2 R_f}{R_2} + \frac{V_3 R_f}{R_3} + \ldots\right]$ *volts*

Supply rating = Voltage per stage × Number of stages *volts*

$V_{\max} = \sqrt{2} \times V_{rms}$ *volts*

$V_{mean} = 0{,}637 \times V_{\max} = \frac{0{,}637}{2} \times V_{\max}$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{2}}{\pi} V_{line}$ *volts*

$V_{mean} = \frac{\sqrt{2}}{2 \cdot \pi} V_{rms} \times (1 + Cos\,\alpha)$ *volts*

$V_{mean} = \frac{\sqrt{2}}{\pi} V_{rms} \times (1 + Cos\,\alpha)$ *volts*

$V_{mean} = \frac{2 \cdot \sqrt{2}}{\pi} V_{rms} \times Cos\,\alpha$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{3}\sqrt{2}}{2\ \pi} V_{per\ phase} \times (1 + Cos\,\alpha)$ *volts*

$V_{mean} = \frac{3 \cdot \sqrt{2}}{\pi} V_{line} \times Cos\,\alpha$ *volts*

$$f_n = \frac{1}{2\pi} \times \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$$ *hertz*

$\int^n$ = *Amplification* *hertz*

$$\int = \frac{\pi \cdot R}{\omega \cdot L}$$

$$C = \frac{t}{R_L} = \frac{\tau}{R}$$ *farads*

$$d = \frac{v \cdot t}{2}$$ *metres*

$$\omega = 0{,}5 \times C \times V^2 = 0{,}5 \times L \times I^2$$ *joules*

$$q = \frac{h \cdot v}{E \cdot \lambda}$$ *coulombs*

$$n = t \times f = 1 + \frac{\ln 100}{\int}$$ *number of oscillations*

$$\eta = 1{,}4 \cdot 10^{-9} \times E \times Z$$ *per unit*

$$^{\circ}C_{\max} = V_{i\max} \div V / ^{\circ}C$$ *Celsius*