201311T069

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T350(E)(N21)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N5

(8080235)

21 November 2013 (X-Paper)
09:00–12:00

This question paper consists of 4 pages and 1 diagram sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
COMMUNICATION-ELECTRONICS N5
TIME: 3 HOURS
MARKS: 100

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. Write neatly and legibly.

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QUESTION 1

1.1 What is understood by the term *selectivity* as applied to electronic circuits? (3)

1.2 An inductor with a Q-factor of 100 and a DC resistance of 100 Ω is connected in series with a capacitor and a 10 mV AC supply. If the frequency of operation is 455 kHz and a constant current of 0,1 A is required, calculate the following circuit parameters:

1.2.1 The voltage drop across the capacitor (5)

1.2.2 The inductance value (3)

1.3 Refer to FIGURE 1 on the DIAGRAM SHEET (attached) and do the following for a supply current of 50 A $\angle$ 300:

1.3.1 Calculate I_{LR} (6)

1.3.2 Determine I_C (5)
[22]

QUESTION 2

Determine the following parameters for the circuit of FIGURE 2 on the DIAGRAM SHEET (attached). The two coils have a mutual inductance of 7,35 μH:

2.1 The quality factors Q_P and Q_S (6)

2.2 The critical coupling coefficient (2)

2.3 The actual coupling coefficient (2)
[10]

QUESTION 3

3.1 Design, draw and label a circuit that will suppress all frequencies above 4,3 kHz. The circuit must be of the π-type with an impedance of 600 Ω. (12)

3.2 Make simple, labelled sketches to represent the following filters in terms of impedance. Write the equations for the series and shunt impedances below the sketch in each case:

3.2.1 A π-type low pass filter

3.2.2 A π-type high pass filter

3.2.3 A T-type low pass filter

(3 x 4) (12)
[24]

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QUESTION 4

A symmetrical T-type network gives the following readings:

An open-circuit impedance of 400 ohm and a short-circuit impedance of 300 ohm

Derive the equation for the shunt and series impedance and draw the network with its impedance values inserted. **[15]**

QUESTION 5

Make use of simple sketches to represent the frequency spectrum of the RF signal of an AM transmitter when the following are transmitted:

5.1 The RF carrier and both sidebands (3)

5.2 The upper sideband only (1)

5.3 The upper and lower sidebands without the carrier (2)

5.4 The RF carrier only (1)
[7]

QUESTION 6

Name any FM demodulator that you have studied and draw a labelled diagram of the circuit. **[12]**

QUESTION 7

7.1 Make a neat, labelled sketch of a Yagi antenna consisting of THREE elements. (6)

7.2 Define or describe the following terms:

7.2.1 Impedance matching (2)

7.2.2 Resonant antenna (2)
[10]

TOTAL: 100

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DIAGRAM SHEET

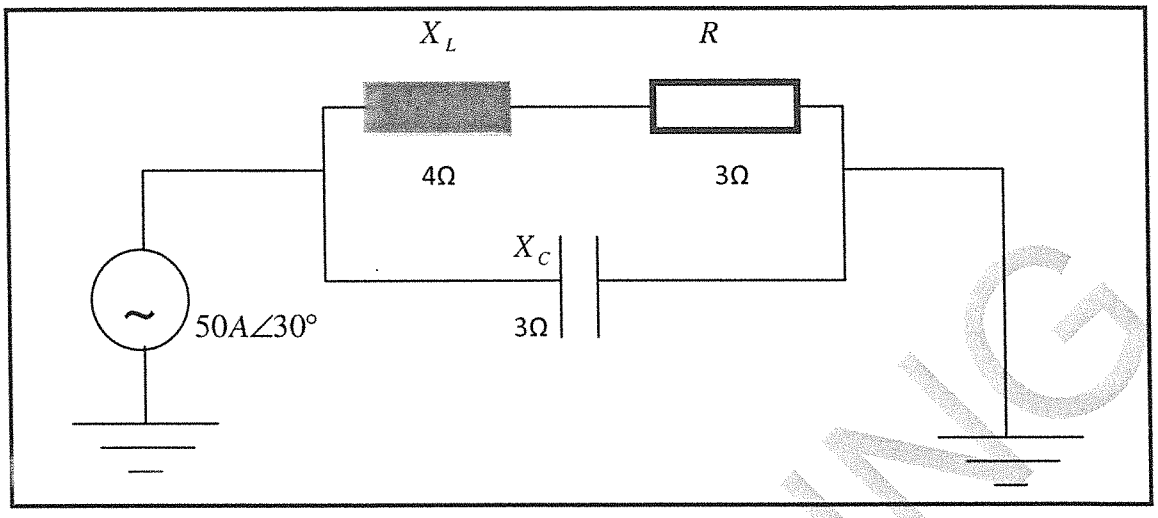

FIGURE 1

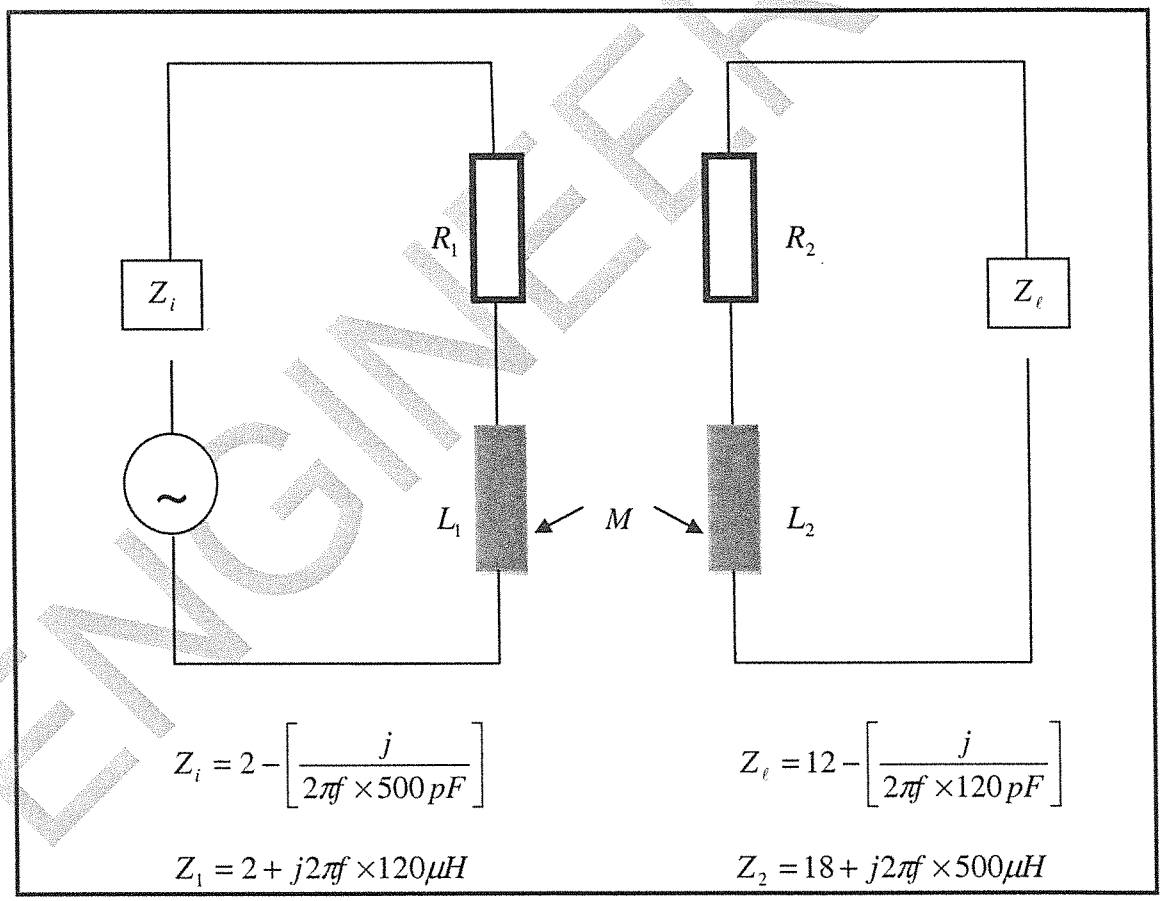

FIGURE 2

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T300(E)(N26)T

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

COMMUNICATION-ELECTRONICS N5

(8080235)

26 November 2014 (Y-Paper)
13:00–16:00

Calculators may be used.

This question paper consists of 5 pages and a formula sheet of 5 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
COMMUNICATION-ELECTRONICS N5
TIME: 3 HOURS
MARKS: 100

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. Ensure that your work is legible and that diagrams are clearly labelled.
5. Keep questions and subsections of questions together.
6. Rule off on completion of EACH answer.
7. Consider the following two examples regarding the use of units in calculations:

   INCORRECT: $V = IR = 10 \times 2 = 20$

   CORRECT: $V = IR = (10\ A) \times (2\ \Omega) = 20\ V$

8. Write neatly and legibly.

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QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

1.1.1 At resonance the frequency of the inductive and capacitive reactance of the inductor and the capacitor is equal.

1.1.2 The coefficient of coupling expresses the degree of coupling between the primary and secondary coils.

1.1.3 An attenuator is fundamentally a power ratio that can be expressed in terms of current when the resistances are equal.

1.1.4 A constant K-filter does not have a sharp cut-off frequency.

1.1.5 The microphone in an AM transmitter converts electrical audio-frequency signals into mechanical sound waves.

1.1.6 The demodulator clips the peaks and troughs of the RF waves thereby removing any interference caused by amplitude variations.

1.1.7 Depth of modulation depends upon the amount of frequency deviation during the peaks of the modulating signal.

1.1.8 In a double side-band transmission only on one side band is contained when the carrier frequency is transmitted.

1.1.9 The folded dipole is ideal for point-to-point communication at VHF frequencies.

1.1.10 Bode diagrams are used as the approximation of the frequency and phase response of the RC circuit. (10 x 1) **[10]**

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QUESTION 2

2.1 An AC supply of 50 V is applied across a coil having an inductive reactance of 12 Ω and a resistance of 5 Ω.

Calculate the following:

(a) Total current

(b) Phase angle

(c) Power factor

(d) Draw the phasor diagram (15)

2.2 Use any method to derive from first principle the formula of the Q-factor of a capacitor. (10)
[25]

QUESTION 3

Explain the THREE different coupling methods used on two coils. (3 x 2) **[6]**

QUESTION 4

Derive from first principle, the equation for the characteristic impedance of the π-section network. **[10]**

QUESTION 5

5.1 Design a T-type attenuator pad with 10 dB attenuation for a 600 Ω transmission line. (11)

5.2 Define *insertion loss of the network.* (3)
[14]

QUESTION 6

A DSB AM transmitter gives a power output of 5 kW when 95% is modulated by a sine wave.

The carrier is 20% speech modulated and the carrier as well as one sideband is suppressed.

Calculate the mean output power in the remaining sideband. **[10]**

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QUESTION 7

Draw a neat, labelled block diagram of an AM superheterodyne receiver and explain the function of each stage. **[15]**

QUESTION 8

Explain the THREE differences by considering the transmission of the following side-band transmitters:

8.1 DSB (3)

8.2 SSB (3)

8.3 Define effective aperture of an antenna (4)
[10]

TOTAL: 100

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FORMULA SHEET

Inductive Reactance

$$X_L = 2\pi fL$$

Capacitive Reactance

$$X_c = \frac{1}{2\pi\ fC}$$

Series formulae

$$Z_T = \sqrt{R^2 + (X_L - X_c)^2}$$

$$\tan\theta = \frac{X_L - X_c}{R}$$

$$BW = \frac{f_o}{Q} = \frac{R}{2\pi\ L}$$

$$p.f = Cos\phi$$

$$P = VICos\phi$$

$$Y = \frac{1}{Z} = G \pm jB$$

Parallel formulae

$$I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$$

$$\tan\theta = \frac{I_C - I_L}{I_R}$$

$$I_X = I_C - I_L$$

$$p.f = Cos\phi$$

$$P = VICos\phi$$

$$Y_T = Y_1 + Y_2$$

Series resonance

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$Z = R$$

$$\phi = 0^\circ$$

$$p.f = Cos\phi = 1$$

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$BW = \frac{f_o}{Q} = \frac{R}{2\pi\ L}$$

Parallel resonance

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$Z_D = \frac{L}{RC}$$

$$\phi = 0^\circ$$

$$p.f = Cos\phi = 1$$

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$BW = \frac{f_o}{Q} = \frac{R}{2\pi\ L}$$

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FILTERS

Low pass

$$R_o = \sqrt{\frac{L}{C}}$$

$$f_c = \frac{1}{\pi\sqrt{LC}}$$

$$C = \frac{1}{\pi\ R_o\ f_c}$$

$$L = \frac{R_o}{\pi\ f_c}$$

$$Z_{OT} = \sqrt{\frac{L}{C}} \times \sqrt{1 - \frac{\omega^2 LC}{4}}$$

$$Z_{o\pi} = \frac{R_o}{\sqrt{1 - \frac{\omega^2 LC}{4}}}$$

High pass

$$R_o = \sqrt{\frac{L}{C}}$$

$$f_c = \frac{1}{4\pi\sqrt{LC}}$$

$$C = \frac{1}{4\pi\ R_o\ f_c}$$

$$L = \frac{R_o}{4\pi\ f_c}$$

$$Z_{OT} = \sqrt{\frac{L}{C}} \times \sqrt{1 - \frac{1}{4\omega^2 LC}}$$

$$Z_{o\pi} = \frac{R_o}{\sqrt{1 - \frac{1}{4\omega^2 LC}}}$$

SYMMETRICAL FOUR-TERMINAL NETWORKS

T- Network

$$Z_{in} = Z_{out\ /\ uit}$$

$$Z_{OT} = \sqrt{Z_{oc} Z_{sc}}$$

$$Z_{OT} = \sqrt{\frac{Z_1^{\ 2}}{4} + Z_1 Z_2} = \frac{Z_1 Z_2}{Z_{o\pi}}$$

$$Z_1 = 2\left[Z_{oc} - \sqrt{Z_{oc}(Z_{oc} - Z_{sc})}\right]$$

$$Z_2 = \sqrt{Z_{oc}(Z_{oc} - Z_{sc})}$$

π -Network

$$Z_{in} = Z_{out\ /\ uit}$$

$$Z_{O\pi} = \sqrt{Z_{oc} Z_{sc}}$$

$$Z_{O\pi} = \frac{Z_1 Z_2}{\sqrt{\frac{Z_1^{\ 2}}{4} + Z_1 Z_2}} = \frac{Z_1 Z_2}{Z_{OT}}$$

$$Z_1 = \frac{Z_{sc}\left[Z_{oc} \pm \sqrt{Z_{oc}\ (Z_{oc} - Z_{sc})}\right]}{Z_{oc} + \sqrt{Z_{oc}(Z_{oc} - Z_{sc})} - Z_{sc}}$$

$$Z_2 = \frac{1}{2}\left[Z_{oc} \pm \sqrt{Z_{oc}(Z_{oc} - Z_{sc})}\right]$$

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ASYMMETRICAL FOUR-TERMINAL NETWORKS

L-Section Image Impedance

$$Z_{o_1} = \sqrt{Z_1^2 + Z_1 Z_2}$$

$$Z_{o_2} = \frac{Z_1 Z_2}{\sqrt{Z_1^2 + Z_1 Z_2}}$$

L-Section Iterative Impedance

$$Z'O_1 = \sqrt{\frac{Z_1^2}{4} + Z_1 Z_2} + \frac{Z_1}{2}$$

$$Z'O_2 = \sqrt{\frac{Z_1^2}{4} + Z_1 Z_2} - \frac{Z_1}{2}$$

NETWORK CONVERSIONS

T → π conversion

$$ZA = \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_2}$$

$$ZB = \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_3}$$

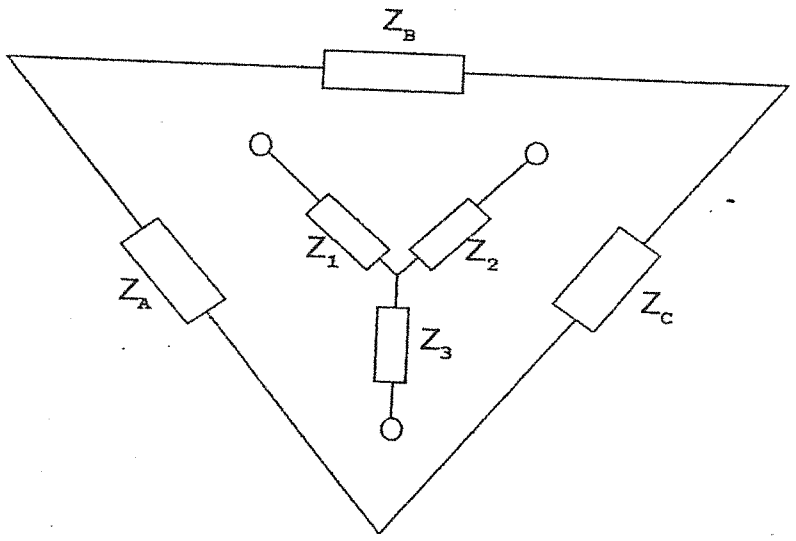
$$ZC = \frac{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}{Z_1}$$

π → T conversion

$$Z_1 = \frac{Z_A Z_B}{Z_A + Z_B + Z_C}$$

$$Z_2 = \frac{Z_B Z_C}{Z_A + Z_B + Z_C}$$

$$Z_3 = \frac{Z_A \,.\, Z_C}{Z_A + Z_B + Z_C}$$



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ATTENUATORS IN GENERAL

$dB = 8{,}686 \times \text{Neper}$

$$dB = 10 \log \left(\frac{P_{in}}{P_{uit/out}} \right)$$

$dB = 20 \log N$

$$Insertion\ Loss = 10 \log \frac{P_1}{P_2} = 20 \log \frac{I_1}{I_2}$$

SYMMETRICAL ATTENUATORS

$$N = \frac{I_{in}}{I_{out/uit}} = \sqrt{\frac{P_{in}}{P_{out/uit}}}$$

T-Type

$$R_a = \frac{R\,(N-1)}{N+1}$$

$$R_b = \frac{2RN}{N^2-1}$$

π-Type

$$R_a = \frac{R\,(N+1)}{N-1}$$

$$R_b = \frac{R(N^2-1)}{2N}$$

Bridged T

$$R_a = R = Z_o$$

$$R_b = R\,(N-1)$$

$$R_c = \frac{R}{N-1}$$

ASYMMETRICAL ATTENUATORS

$$N = \sqrt{\frac{P_{in}}{P_{out/uit}}}$$

L-Type

$$R_a = \sqrt{R_1(R_1 - R_2)}$$

$$R_b = \sqrt{\frac{R_1 R_2^2}{R_1 - R_2}}$$

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MUTUAL INDUCTANCE

$$M = \sqrt{L_p \times L_s} \times k$$

$$k = \frac{M}{\sqrt{L_p P_s}}$$

$$k_c = \frac{1}{\sqrt{Q_p Q_s}}$$

$$Z_c = \frac{(\omega M)^2}{Z_s}$$

$$f_1 = \frac{f_o}{\sqrt{1+k}}$$

$$f_2 = \frac{f_o}{\sqrt{1-k}}$$

$$Q_p = \frac{X_{LP}}{R_p}$$

$$Q_s = \frac{X_{LS}}{R_s}$$

Dot rule

$$L_T = L_1 + L_2 + 2M$$

$$L_T = L_1 + L_2 - 2M$$

AM

$$m = \frac{V_m}{V_c}$$

$$P_{DSB} = \frac{m^2 Pc}{2}$$

$$P_T = P_c\left(1 + \frac{m^2}{2}\right)$$

$$m_T = \sqrt{m_1^2 + m_2^2}$$

$$v_c = V_c Sin\omega_c t + \frac{mV_c}{2}\cos(\omega_c - \omega_m)t - \frac{mV_c}{2}\cos(\omega_c + \omega m_m)t$$

FM

$$v_c = V_c \sin(\omega_{\cos} t - m\cos\omega_M t)$$

$$BW = f_{\text{mod}} \times (\text{number of sidebands}) \times 2$$

SHANNON-HARTLEY

$$C = \Delta f \log_2\left(1 + \frac{S}{N}\right)$$

$$dB = 10\log\left(\frac{\text{signal power}}{\text{noise power}}\right)$$

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