higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T300(E)(A8)T

# APRIL EXAMINATION

# NATIONAL CERTIFICATE

# COMMUNICATION ELECTRONICS N5

(8080235)

**8 April 2014(Y-Paper)**
**13:00–16:00**

**Calculators may be used.**

**This question paper consists of 5 pages.**

ENGINEERING

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

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

ENGINEERING

## 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 With reference to the circuit diagram of FIGURE 1 below, calculate the values of Z1 and Z2 if VZ1 = 4VZ2:

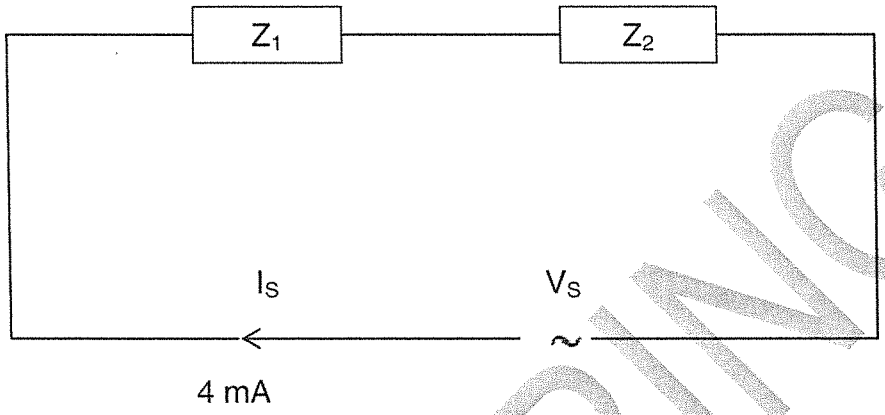


**FIGURE 1** (9)

1.2 Use any method to derive the equation for the resonance frequency of a parallel resonant circuit. (11)
**[20]**

## QUESTION 2

Briefly describe the function of each of the following electronic circuits:

2.1 Demodulator/detector

2.2 Modulator

2.3 Buffer amplifier

2.4 Attenuator (in general)

2.5 Filter

2.6 Transmitting antenna

2.7 Receiving antenna

2.8 Amplifier (in general)

2.9 AGC

2.10 L-type attenuator

(10 x 1) **[10]**

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## QUESTION 3

3.1 What are the THREE requirements of an attenuator? (3)

3.2 Design an attenuator circuit for matching a 300 Ω microphone to an amplifier with an input impedance of 220 Ω. Draw the attenuator circuit and insert all the calculated values. (7)
**[10]**

## QUESTION 4

Derive the equation for the Q-factor of a coil from first principles. **[12]**

## QUESTION 5

Design a filter with a cut-off frequency of 15 kHz and a design impedance of 600 Ω. The filter must suppress/remove ALL the frequencies ABOVE cut-off. **[16]**

## QUESTION 6

Draw a neat, labelled diagram of a typical FM detector/demodulator which you have studied, and label the diagram. **[12]**

## QUESTION 7

A commercial AM broadcasting station makes use of a transmitter with a carrier power of 10 kW. The RF carrier is 100% amplitude-modulated.

7.1 How much power is in the sidebands?

7.2 Make use of a simple sketch to represent the frequency spectrum of the transmitted signal.

7.3 Sketch the spectrum with the upper sideband suppressed and the carrier reduced.

7.4 Sketch the spectrum with the lower sideband and the carrier suppressed.
(3 x 4) **[12]**

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## QUESTION 8

Define the following concepts:

8.1 Antenna losses

8.2 Radiation resistance

8.3 Antenna efficiency

8.4 Directive gain

(4 x 2) **[8]**

**TOTAL: 100**

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# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## APRIL EXAMINATION

## COMMUNICATION ELECTRONICS N5

## 8 APRIL 2014

**This marking guideline consists of 8 pages.**

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## QUESTION 1

$V_{Z1} = 4Vz_2$

$Z_1 = 4\ Z_2$

$Z_T = Z_1 + Z_2$

$= 4\ Z_2 + Z_2$

$= 5\ Z_2$

$Z_T = \frac{V_S}{I_S}$

$= \frac{20\ V}{4\ mA}$

$Z_T = 5\ k\Omega$

$5\ Z_2 = 5\ k\Omega$

$Z_2 = 1\ k\Omega$

$Z_1 = 4\ Z_2 = 4\ k\Omega$ (9)

$$\frac{1}{Z_T} = \frac{1}{Z_{RL}} + \frac{1}{Z_C}$$

$$= \frac{1}{R+j\omega L} + \frac{1}{(-\frac{J}{\omega C})}$$

$$= \frac{1}{R+j\omega L} + \frac{R-j\omega L}{R-j\omega L} + j\omega C$$

$$= \frac{R-j\omega L}{R^2+\omega^2 L^2} + j\omega C$$

$$= \frac{R}{R^2+\omega^2 L^2} - j\frac{\omega L}{R^2+\omega^2 L^2} + j\omega C$$

At resonance the j-term = 0

$$j\omega C - \frac{j\omega L}{R^2+\omega^2 L^2} = 0$$

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$$\frac{j\omega L}{R^2+\omega^2L^2} = j\omega C$$

$$\frac{R^2+\omega^2L^2}{L} = \frac{1}{C}$$

$$R^2+\omega^2L^2 = \frac{1}{C}$$

$$R^2+\omega^2L^2 = \frac{L}{C}$$

$$\omega^2L^2 = \frac{L}{C} - R^2$$

$$\omega^2 = \frac{1}{LC} - \frac{R^2}{L^2}$$

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

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

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

(11)
**[20]**

## QUESTION 2

2.1 To filter out the RF carrier
2.2 To superimpose the AF signal onto the RF carrier
2.3 To match two circuits without introducing a loss
2.4 To weaken a strong signal
2.5 To provide frequency selection
2.6 To convert RF signals into electromagnetic waves
2.7 To convert electromagnetic waves into RF signals
2.8 To strengthen a weak signal
2.9 To prevent signal fading
2.10 To match two circuits

(10 x 1) **[10]**

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## QUESTION 3

3.1 The correct input impedance
The correct output impedance
The required attenuation (3)

3.2 $R_1 = 300\ \Omega$; $R_2 = 220\ \Omega$

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

$$= \sqrt{300(300 - 220)}$$

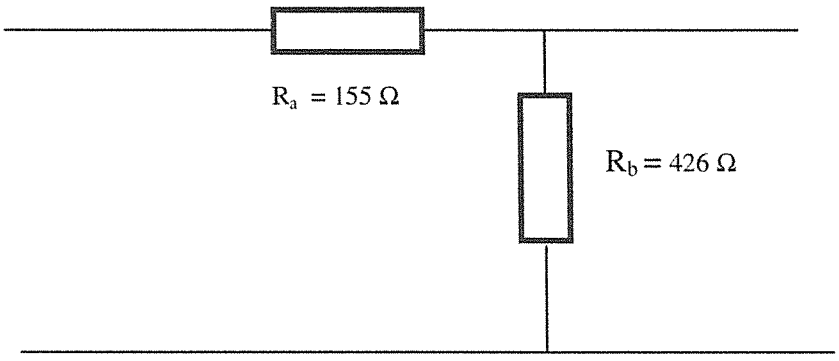
$$= 154.92\ \Omega$$

(3)

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

$$= \sqrt{\frac{300(220)^2}{300-220}}$$

$$= 426.03\ \Omega$$




(7)

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## QUESTION 4

$Q = \frac{WL}{R}$ R

$QR = WL$

i.e. $QR = 2T1\ FL \quad \frac{1}{2\ T1\ \sqrt{LC}}$

$\therefore\ QR = 2T1\ X\ FIL \quad \frac{1}{2\ T1\sqrt{\ LC}}$

$QR = \frac{L}{\sqrt{LC}}$

$QR = \frac{\sqrt{L} \quad X \quad \sqrt{L}}{\sqrt{L} \quad X \quad \sqrt{C}}$

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

$\frac{QR}{R} = \sqrt{\frac{L}{C} \quad X \quad \frac{1}{R}}$

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

[12]

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## QUESTION 5

$f_c$ = 15 kHz ; $R_0$ = 600 Ω

Low pass filter

$$L = \frac{R_0}{\pi f_c} = \frac{600\ \Omega}{\pi (15 \times 10^3\ Hz} = 127.324\ mH$$

$$C = \frac{1}{\pi R_0 f_c} = \frac{1}{\pi (600\ \Omega)(15 \times 10^3\ Hz} = 35.368\ nF$$

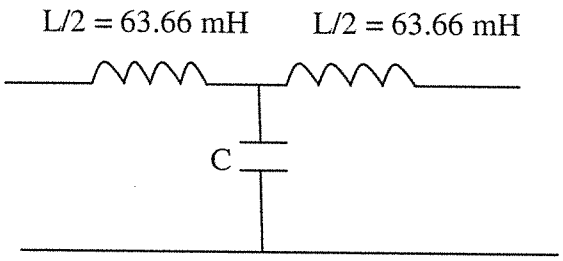
T-type

$$\frac{L}{2} = \frac{127.324\ mH}{2} = 63.66\ mH$$

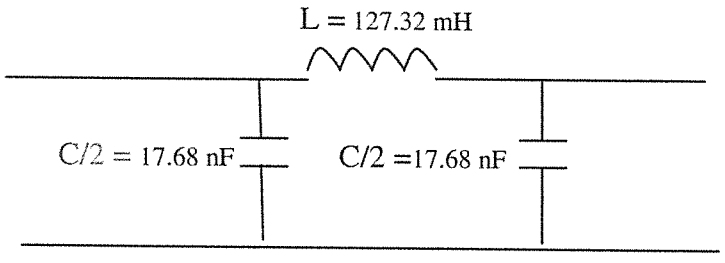
π- type

$$\frac{C}{2} = \frac{35.368\ nF}{2} = 17.68\ nF$$

Implicit L.P acceptable




T-type




π-type

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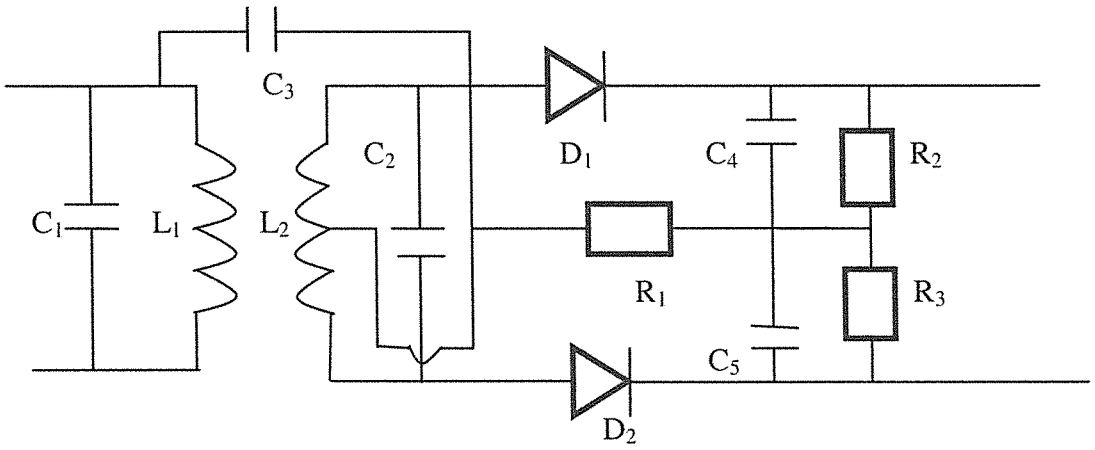
## QUESTION 6




The discriminator

## QUESTION 7

7.1 $P_{RF}$ = 10 kW

M = 100%

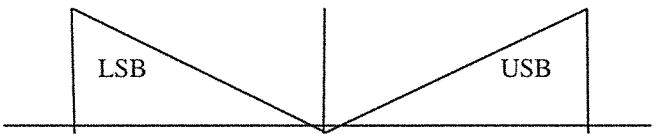
$$P_{DSB} = \frac{m^2 P_{RF}}{2}$$

m = 100 % = 1

$$P_{DSB} = \frac{(1)^2(10\ kW)}{2}$$

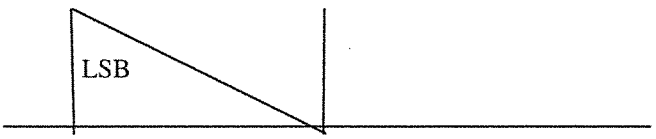
= 5 kW

7.1



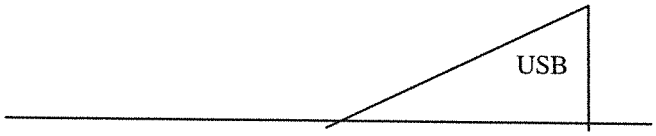

$f_c$

7.3




$f_c$

7.4




$f_c$

## QUESTION 8

8.1 The ratio of radiated power to the total resistance that dissipates the power

8.2 The ratio of power radiated to the square of the current at the feed point.

8.3 As per 8.1

8.4 The ratio of the power density of an antenna to the power density of an isotrope.

(4 x 2) **[8]**

**TOTAL: 100**

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