education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

ELECTRICAL TECHNOLOGY

NOVEMBER 2007

MARKS: 200

TIME: 3 hours

This question paper consists of 14 pages and a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Sketches and diagrams must be large, neat and fully labelled.

3. ALL calculations must be shown correctly to TWO decimal places.

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

5. Non-programmable calculators may be used.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1 South Africa is confronted by shortage of electrical power generation. When building a new power station, engineers have to take society and environmental factors into consideration. State TWO factors that the engineers must take into consideration regarding society and the environment. Motivate your answer. (4)

1.2 Discuss TWO competencies a person will require to be a successful entrepreneur manufacturing electronic toys. (4)

1.3 When dealing with a person who is injured, name ONE precaution, taking HIV/Aids into account. (2)
[10]

QUESTION 2: TECHNOLOGICAL PROCESS

An elderly man has both his hands crippled as a result of rheumatism. He can barely pick up a book. He can use his feet and move his arms. His fingers, however, are useless.

2.1 Develop ONE relevant idea, using electrical technology, that you think is a possible solution to the above-mentioned problem. (5)

2.2 Indicate in tabular form how you will evaluate the design solution of the above-mentioned problem. (5)
[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY ACT

3.1 Accidents are caused by unsafe acts and/or conditions. Answer the following:

3.1.1 List TWO unsafe acts that could cause an accident. (2)

3.1.2 List TWO unsafe conditions that could cause an accident. (2)

3.2 Name the THREE elements of fire. (3)

3.3 Name the type of fire extinguisher in COLUMN B that matches the classes of fire in COLUMN A. Write only the letter (A – C) with the name of the type of fire extinguisher next to the question number (3.3.1 – 3.3.3) in the answer book.

	COLUMN A CLASS OF FIRE	COLUMN B TYPE OF FIRE EXTINGUISHER
3.3.1	Wood, paper, coal, tobacco, grass and other organic materials	A
3.3.2	Flammable liquids and greases, for example alcohol, benzine, oil, paraffin, petrol	B
3.3.3	Fires occuring in the presence of live electrical installations	C

(3)
[10]

QUESTION 4: INSTRUMENTS

FIGURE 4.1 indicates the current flow through a resistor and the relevant voltage across the same resistor. Answer the following questions:

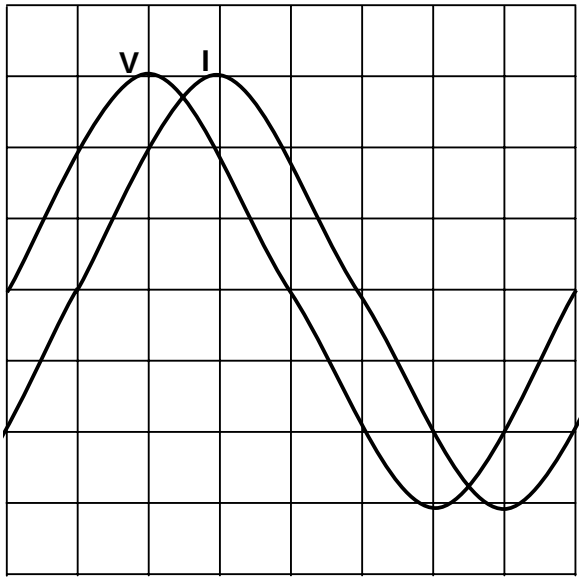


FIGURE 4.1 – SINE-WAVE FORMS

4.1 Determine the phase angle between the voltage and the current. (2)

4.2 Calculate the power factor of the supply. (3)

4.3 List the unique features of a function generator. (5)
[10]

QUESTION 5: PRINCIPLES OF SINGLE-PHASE GENERATION

5.1 An alternating voltage wave form is represented by the following equation:

e = 25 sin 628,3 t volts

Calculate the following, using the equation:

5.1.1 The value of the instantaneous voltage when t = 1 ms (3)

5.1.2 The frequency of the wave form (3)

5.1.3 Describe the term *periodic time* with reference to the wave form (2)

5.2 A coil turns through 270º in 0,5 seconds. Determine the angular velocity of the coil. (4)

5.3 Determine the direct current voltage that must be applied to a lamp to ensure the same brightness as that produced by an alternating current of 200 volts. (3)

[15]

QUESTION 6: THE PRINCIPLES AND EFFECT OF ALTERNATING CURRENT ON RLC CIRCUITS

6.1 FIGURE 6.1 shows an RLC circuit at resonant frequency. Explain what will happen to the reading on each meter, if the frequency is increased above resonant frequency.

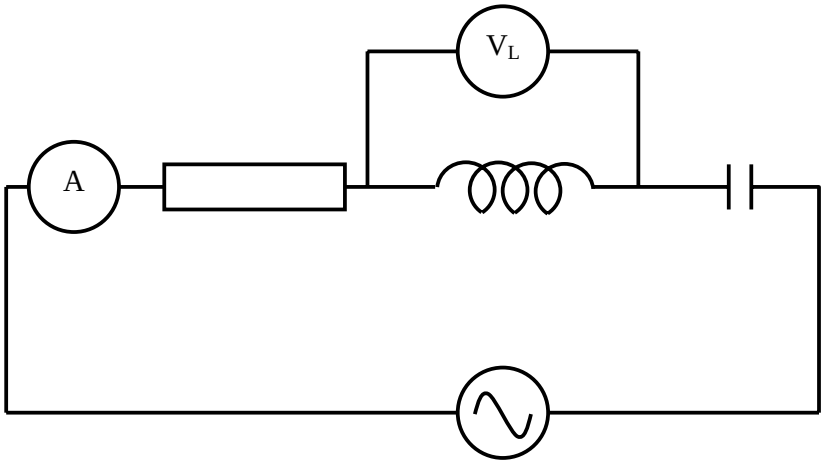


FIGURE 6.1 - RLC CIRCUIT (5)

6.2 A series circuit with a 200 µF capacitor, a 100 mH inductor and a 12 Ω resistor is connected across a 24 V/50 Hz supply.

Calculate the following:

6.2.1 The total impedance of the circuit (9)

6.2.2 The total current flow in the circuit (3)

6.2.3 The resonant frequency of the circuit (4)

6.3 Sketch a phasor diagram that would represent an alternating voltage across a capacitor and the current flow in the capacitor. (3)

6.4 Indicate, with reference to FIGURE 6.2 below, whether the lamp in the circuit will burn more brightly if the frequency is increased or if it is decreased. Give a brief explanation for the option you have chosen.

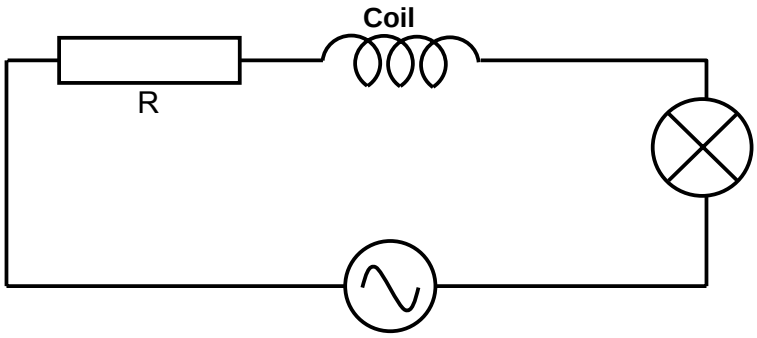


FIGURE 6.2 - RL CIRCUIT (5)

6.5 Is the capacitance of a capacitor dependant on frequency? (1)
[30]

QUESTION 7: SEMICONDUCTOR DEVICES

7.1 Explain the basic functional operation of an NPN bipolar junction transistor (BJT). (4)

7.2 FIGURE 7.1 shows a thyristor-controlled lamp dimming circuit. Explain the basic operation of the circuit.

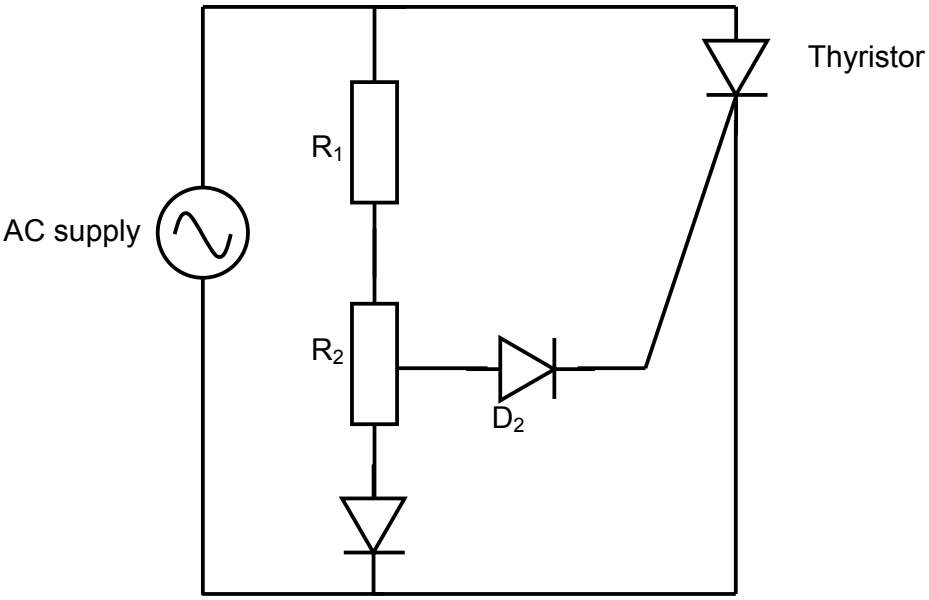


FIGURE 7.1 – THYRISTOR-CONTROLLED CIRCUIT (6)
[10]

QUESTION 8: AMPLIFIER CIRCUITS

8.1 When transistors are utilised as amplifiers, reference is made to the gain of the transistor. Make use of your knowledge of amplifiers to determine the gain of the amplifier, shown in FIGURE 8.1. Note that the input voltage is 0,02 Vp-p and the output voltage is 3 Vp-p.

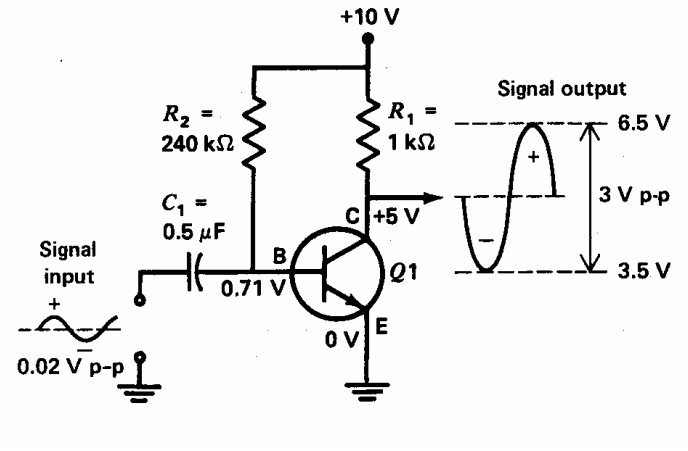


FIGURE 8.1 - COMMON EMITTER AMPLIFIER (3)

8.2 Study the amplifier circuit shown in FIGURE 8.2 and answer the question that follows:

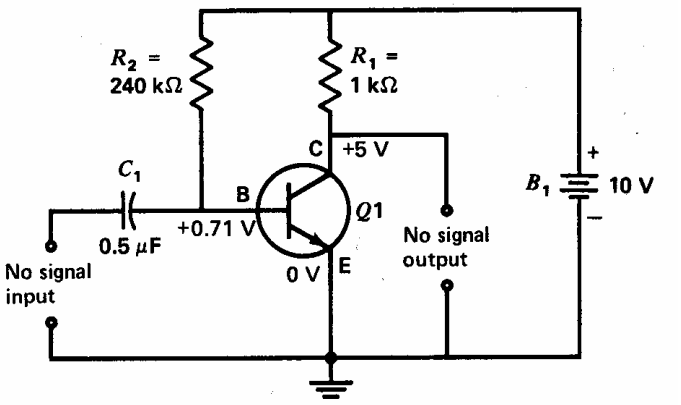


FIGURE 8.2 - COMMON EMITTER AMPLIFIER

Speakers normally have an impedance of 8 ohms (not shown). If the speaker, however, is connected directly to the DC (direct current) supply, it will be damaged beyond repair. How is it then possible that a speaker can be connected to an amplifier circuit without damaging the speaker? Explain your answer. (2)

8.3 Refer to FIGURE 8.3 to determine the value of the load resistor (Rc) to be utilised with a transistor that has a maximum collector current (Ic) of 150 mA and the supply voltage is 24 volts. NOTE: (Vcc = Vce)

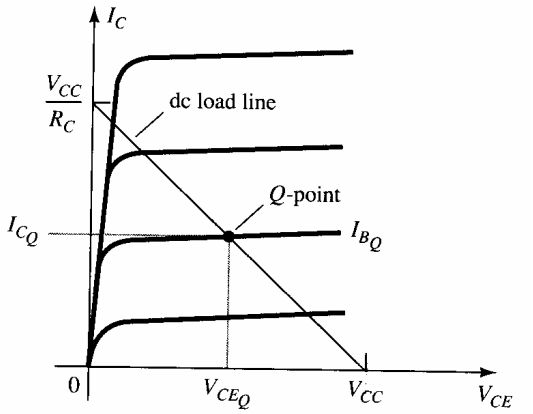
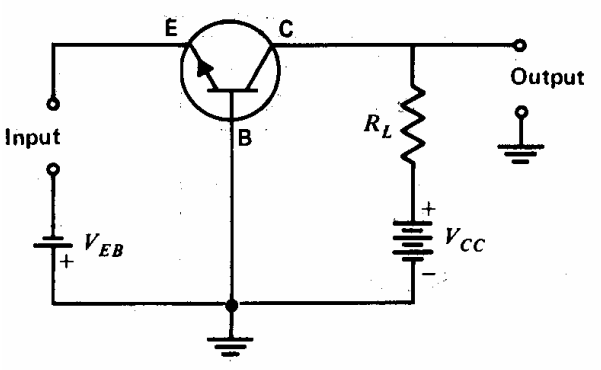


FIGURE 8.3 - TRANSISTOR LOAD LINE (3)

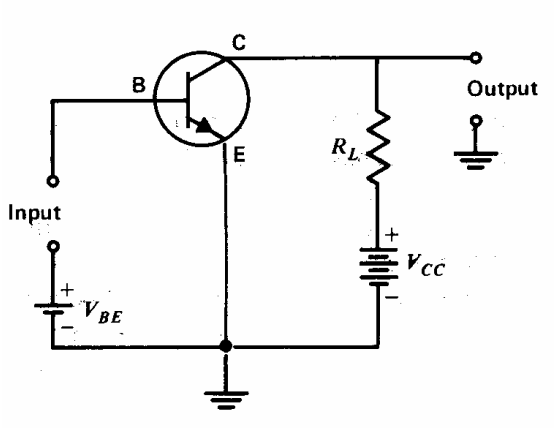
8.4 Transistors can be coupled in a number of configurations, each with its own unique properties. Identify the type of configuration used in each of the following circuits:

8.4.1



(1)

8.4.2



(1)
[10]

QUESTION 9: SINGLE-PHASE TRANSFORMERS

A shop owner living in a rural area needs to install electricity into the shop. The high voltage lines passing next to the shop carry 11 000 volts. The appliances in the shop use 230 volts, which is the standard supply voltage. A single-phase transformer is needed to supply the shop with 230 volts from the 11 000 volt supply line.

Answer the following questions:

9.1 What is the purpose of the transformer? (2)

9.2 Which form of induction is used in transformers? (2)

9.3 Name TWO types of transformer cores, which are used in the construction of transformers. (2)

9.4 Calculate the following:

9.4.1 The number of secondary turns if there are 3 600 primary turns (3)

9.4.2 The primary current if 60 A is drawn from the secondary current (3)

9.4.3 The kVA rating of the transformer (3)

[15]

QUESTION 10: POWER SUPPLIES

10.1 A power supply produces a regulated direct current (DC) from the mains alternating current. Make use of a neatly, labelled block diagram to show the process of a changing alternating current (AC) to a regulated direct current (DC). The wave forms must be depicted at every stage. (5)

10.2 Briefly state the purpose of the following components in FIGURE 10.1:

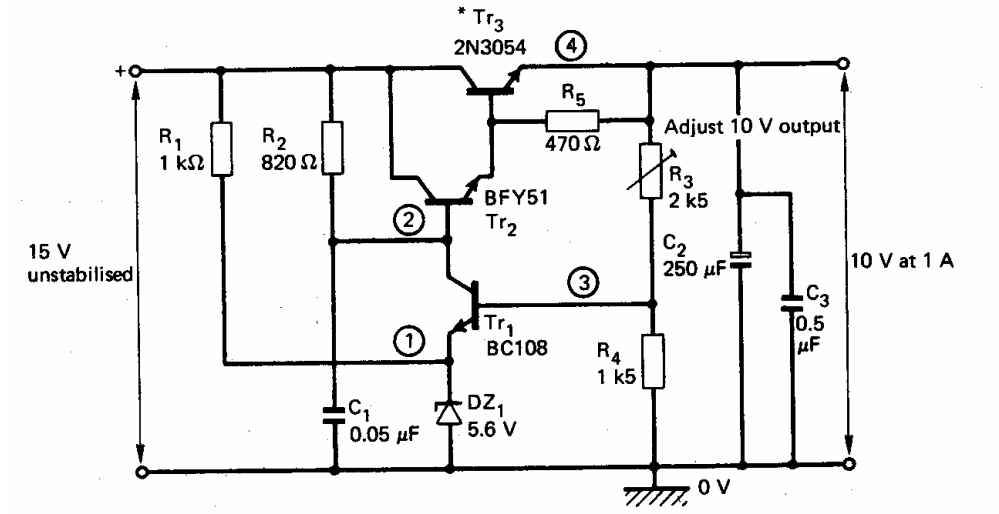


FIGURE 10.1 - REGULATED POWER SUPPLY CIRCUIT

10.2.1 DZ1 – 5,6 V (1)
10.2.2 R3 - 2k5 (1)
10.2.3 C1 - 0,05 µF (1)

10.3 Make a sketch of TWO neatly labelled wave forms to illustrate the difference between *full-wave* and *half-wave rectification*. (2)

10.4 FIGURE 10.2 shows a shunt voltage regulator circuit. Make use of your knowledge of Zener diodes to explain what happens when the input voltage to the regulator suddenly rises and then falls.

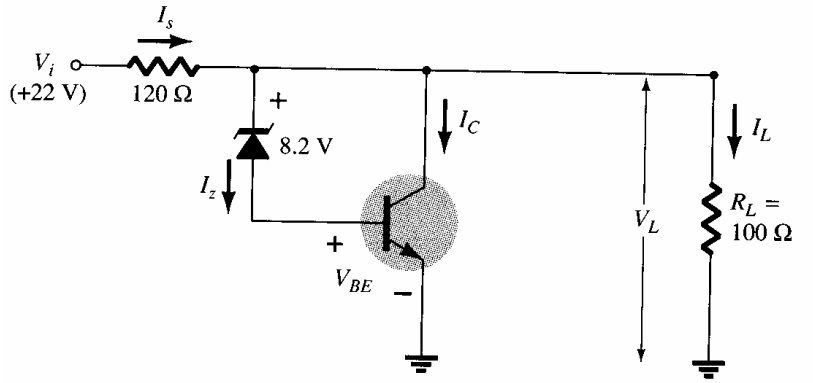


FIGURE 10.2 - SHUNT REGULATED CIRCUIT (4)

10.5 A good power supply (well designed and built) delivers a constant output voltage to its load. Name ONE other property a good power supply must have. (1)

[15]

QUESTION 11: LOGIC CIRCUITS

11.1 Convert the following numbers from binary to decimal:

11.1.1 1011_2 (1)
11.1.2 11001_2 (1)

11.2 Study the logic circuit in FIGURE 11.1 and use it to answer the following questions:

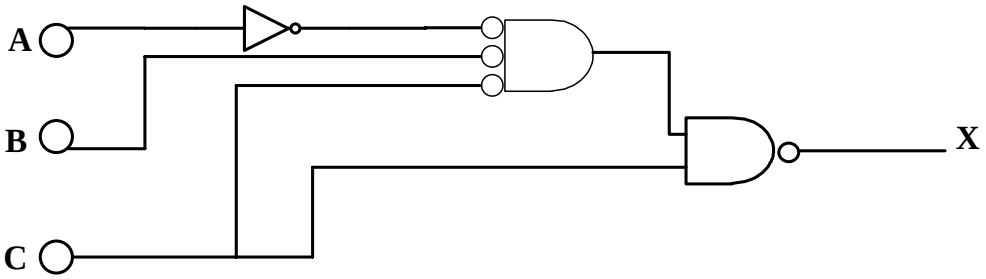


FIGURE 11.1 - LOGIC GATE NETWORK

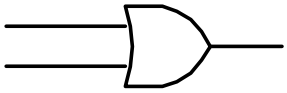
11.2.1 Determine the logic state (1 or 0) of X, if:

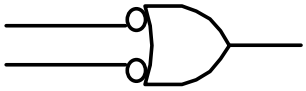
A=1
B=0
C=0 (1)

11.2.2 Determine the logic state (1 or 0) of X, if:

A=0
B=1
C=0 (1)

11.3 Identify the following logic gates:

11.3.1  (1)

11.3.2  (1)

11.4 List TWO applications of logic gates. (2)

11.5 What is the main difference between a *logic system* and an *analogue system*? (2)

11.6 Make a sketch of a logic circuit for the following Boolean equation:

$$F = \overline{\overline{A.B} + \overline{A.C}}$$ (3)

11.7 Simplify the Boolean equation in QUESTION 11.6. (7)
[20]

QUESTION 12: PROTECTIVE DEVICES

12.1 Make a sketch of a symbol of a domestic miniature circuit breaker (MCB). (1)

12.2 Briefly explain how the time delay in a miniature circuit breaker (MCB) is achieved at a light overload. (4)

12.3 State the miniature circuit breaker (MCB) current ratings for the following subcircuits, according to the accepted code of practice for the wiring of premises as regulated by SANS 10142: (NOTE: SANS 10142 replaced SABS 0142 in 2003.)

12.3.1 Stove (1)
12.3.2 Geyser (1)
12.3.3 Plug outlets (1)
12.3.4 Lights (1)
12.3.5 Bell (1)
[10]

QUESTION 13: OPERATING PRINCIPLES OF SINGLE-PHASE MOTORS

13.1 Refer to FIGURE 13.1 and answer the following questions:

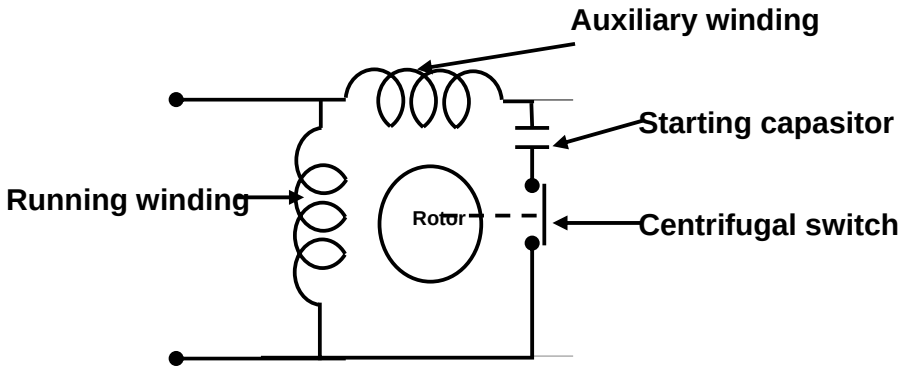


FIGURE 13.1 - ELECTRICAL MOTOR

13.1.1 Name the type of motor represented in FIGURE 13.1. (1)

13.1.2 Explain the function of the centrifugal switch. (2)

13.1.3 What will happen to the motor if the capacitor is defective and it is an open circuit? (2)

13.1.4 Make TWO sketches to indicate how the direction of rotation of this motor can be changed. (6)

13.1.5 State the application of the motor in FIGURE 13.1 and include examples of where it is used. (3)

13.2 Make a drawing of a neatly, labelled circuit diagram to show the internal electrical circuit of a single-phase capacitor-start capacitor-run motor. (7)

13.3 What is the function of the two capacitors used in a single-phase capacitor-start capacitor-run motor? (4)
[25]

QUESTION 14: COMMUNICATION SYSTEMS

14.1 Cellular phones have radio transmitters and receivers that enable them to both receive and transmit radio signals in data format. If this is the case, what is the purpose of cell phone towers? (1)

14.2 Radio frequency waves are frequently referred to as carrier waves. What does this mean? (1)

14.3 Radio receivers make use of frequency dividers to lower the frequency of an input signal. Using this information, determine the output frequency of the block diagram in FIGURE 14.1.

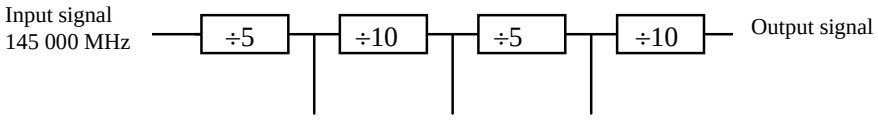


FIGURE 14.1 - DIVIDE BY - BLOCK DIAGRAM (4)

14.4 Radios normally do not receive sufficiently strong signals unless they have an antenna attached. Amateur radio operators use elaborate antenna arrays to improve radio reception. Briefly explain how antennae assist radio receivers in their operation. (4)
[10]

TOTAL: 200

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ELECTRICAL TECHNOLOGY GRADE 11/ ELEKTRIESE TEGNOLOGIE GRAAD 11

FORMULA SHEET FORMULEBLAD

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + ... \frac{1}{Rn}$$

$$Rs = R1 + R2 + R3 + ...Rn$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

$$V = I \times R$$

$$P = V \times I$$

$$P = I^2 \times R$$

$$P = \frac{V^2}{R}$$

$$R_t = R_o(1 + \infty_o t)$$

$$R = \frac{\rho l}{a}$$

$$\tau = R \times C$$

$$\tau = \frac{R}{L}$$

$$a = \frac{\pi d^2}{4}$$

Pf = Cos θ

$$e = EmSin\theta$$

$$\omega = 2\pi F$$

$$E_{rms} = Em \times 0.707$$

$$E_{ave} = Em \times 0{,}637$$

$$E_{wgk} = Em \times 0{,}707$$

$$E_{gem} = Em\times),637$$

$$X_L = 2\pi FL$$

$$X_C = \frac{1}{2\pi FC}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$I_Z = \sqrt{I_R{}^2 + (I_{XL} - I_{XC})^2}$$

$$V_Z = \sqrt{V_R{}^2 + (V_{XL} - V_{XC})^2}$$

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

$$Gain = \frac{Vout}{Vin}$$

$$Wins = \frac{Vuit}{Vin}$$

$$Ic = \frac{Vcc}{Rc}$$

$$\frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is}$$

$$S = Vp \times Ip$$

$$\overline{A.B} = \overline{A} + \overline{B}$$

$$T = \frac{1}{F}$$

$$V = {}^{V}\!/_{Div} \times Div$$

$$Iz = \frac{Vz}{Z}$$

$$P = V.I.Cos\theta$$

$$V_O = V_{Zener} - V_{basis}$$

$$V_{CE} = V_I - V_O$$

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