education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

ELECTRICAL TECHNOLOGY

EXEMPLAR 2007

MARKS: 200

TIME: 2 hours

This question paper consists of 16 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 and rounded off 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 A fellow pupil cuts him-/herself while working in the workshop. Taking cognisance of HIV/Aids, do you have a responsibility to help him/her? Explain your answer. (3)

1.2 Technology is expanding and growing every day. State ONE example of advancement in technology and explain how it has affected your life in a positive way as well as in a negative way. (4)

1.3 Describe THREE skills that a successful entrepreneur requires. (3)

[10]

QUESTION 2: TECHNOLOGICAL PROCESS

People walking and cycling along the side of the road after dark, are not easily seen by passing traffic. Such an action may cause fatal accidents. These people need an electronic warning sign that they can wear to alert the traffic and thus protect themselves.

2.1 Write the design brief for the above-mentioned problem. (4)

2.2 Develop THREE specifications for the design solution to the problem. (6)

[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY ACT

3.1 An accident is an unplanned event often caused by unsafe acts and/or conditions that result in/or have the potential for physical harm to persons and /or damage to equipment. Identify which of the following illustrations represent an unsafe act and which represent an unsafe condition:

3.1.1

(1)

3.1.2

(1)

3.1.3

(1)

3.1.4

(1)

3.2 Identify the following symbolic safety signs:

3.2.1  (1)

3.2.2  (1)

3.2.3  (1)

3.2.4  (1)

3.3 Explain the term *plant housekeeping*. (2)
[10]

QUESTION 4: INSTRUMENTS

FIGURE 4.1 shows the display of a sine wave on the screen of an oscilloscope. The scale setting is as follows:

Vertical: 10 V/division
Horizontal: 2,5 ms/division

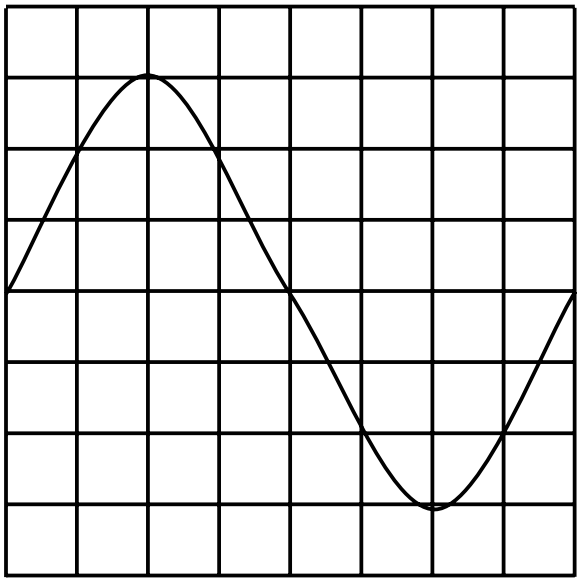

FIGURE 4.1 - SINE WAVE FORM

Calculate the following:

4.1 The maximum value of the voltage (2)

4.2 The effective value of the voltage (3)

4.3 The time to complete ONE full cycle (2)

4.4 The frequency of the cycle (3)
[10]

QUESTION 5: PRINCIPLES OF SINGLE-PHASE GENERATION

5.1 Describe what happens if a conductor is rotated through a two-pole magnetic field. (3)

5.2 An alternating current wave form is represented by the following equation:
i = 12 sin 314t

Using this equation, calculate the following:

5.2.1 The RMS value of the waveform (2)

5.2.2 The current value after 1,5 ms (4)

5.3 Refer to FIGURE 5.1 and make use of Kirchhoff's current law to calculate the unknown current.

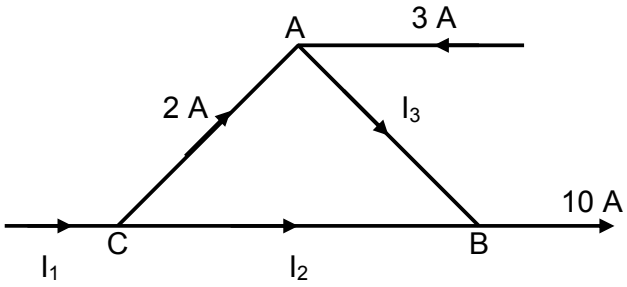

FIGURE 5.1 - CURRENT DISTRIBUTION (6)
[15]

QUESTION 6: PRINCIPLES OF AC ON R, L AND C COMPONENTS

6.1 Explain the term *impedance* with reference to an RLC circuit. (4)

6.2 The tuning circuit of a radio/TV consists of a 75 mH coil, 220 µF capacitor and a 22 Ω resistor, all connected in series 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 phase angle between the supply current and the voltage (3)

6.2.4 Draw a neatly labelled phasor diagram, not necessarily to scale, representing the voltages and current in the circuit. (7)

6.3 Describe ONE practical method to determine whether an RLC series circuit is at resonant frequency. (4)
[30]

QUESTION 7: OPERATING PRINCIPLES OF SEMI-CONDUCTOR DEVICES

7.1 Refer to FIGURE 7.1 and state the conditions for the transistor to switch on and conduct.

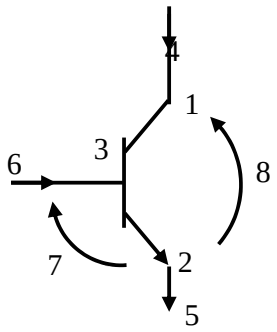

FIGURE 7.1 - NPN TRANSISTOR

(6)

7.2 Explain the basic functional operation of a thyristor. (4)
[10]

QUESTION 8: AMPLIFIER CIRCUITS

Bipolar junction transistors are widely used in electronics and can be implemented as either a switch or an amplifier.

In order for a transistor to be utilised as an amplifier, it needs to be biased in a certain manner. When biasing is applied correctly, a transistor will amplify the small input signal to create an enlarged output signal.

8.1 With reference to information provided, what is *biasing*? (1)

8.2 In FIGURE 8.1 the input signal into the common emitter amplifier is amplified and represented at the output, but with a 180° phase shift.

Explain why this phase shift occurs. (Make specific reference to the internal resistance of the transistor and the effect it has on the output signal.)

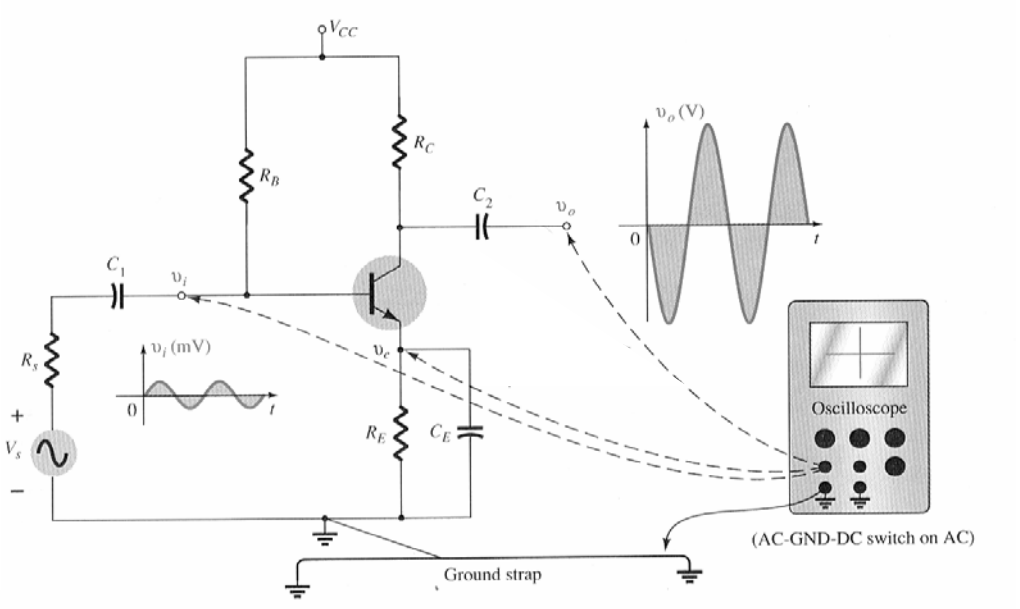

FIGURE 8.1 - COMMON EMITTER AMPLIFIER (6)

8.3 Refer to FIGURE 8.2 and explain what is meant by the Q-point, with reference to the operation of a transistor as an amplifier.

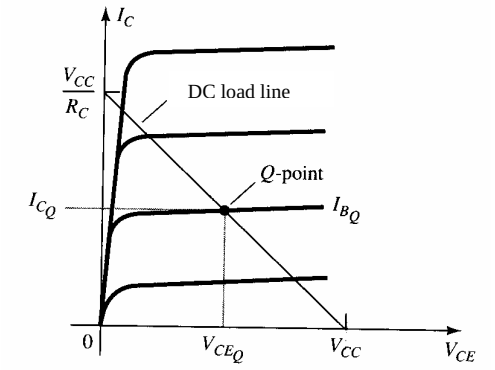

FIGURE 8.2 - TRANSISTOR OPERATION (1)

8.4 Explain, in your own words, why it is necessary to calculate the correct values for the biasing resistors in an amplifier circuit. (2)

[10]

QUESTION 9: TRANSFORMERS

9.1 Draw a neat, labelled circuit diagram of a basic single-phase transformer. (4)

9.2 Mr Manana's dwelling is supplied by a single-phase transformer. When he uses all the appliances the transformer supplying his dwelling gets hot. The transformer used is a 11 000 V/230 V.

9.2.1 What could be the reason for the transformer getting too hot? (2)

9.2.2 There are different methods used to cool transformers. Name THREE methods used to cool a transformer. (3)

9.2.3 Calculate the maximum current that can be drawn by the transformer from the supply if the kVA rating of the transformer is given as 1 100 kVA. (3)

9.2.4 Calculate the current that can be supplied by the transformer. (3)

[15]

QUESTION 10: POWER SUPPLIES

Power supply circuits are designed to provide electronic circuits with a stable voltage as well as a current source. FIGURE 10.1 shows a typical power-supply block diagram.

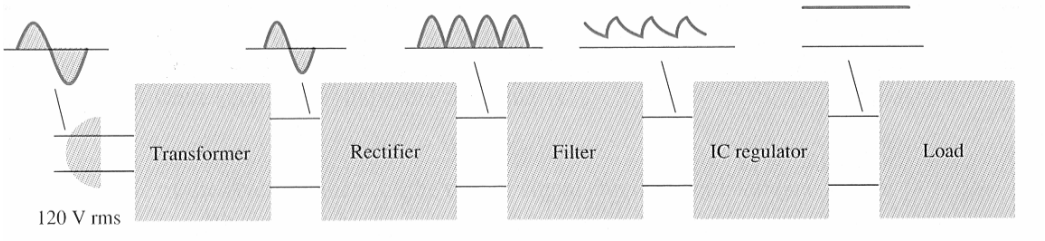

FIGURE 10.1 - POWER SUPPLY BLOCK DIAGRAM

10.1 Refer to FIGURE 10.1 and describe the functions of the following stages in the power supply:

10.1.1 Transformer (1)
10.1.2 Rectifier (1)

10.2 FIGURE 10.2 shows two wave forms. Describe what happened to the wave on the right.

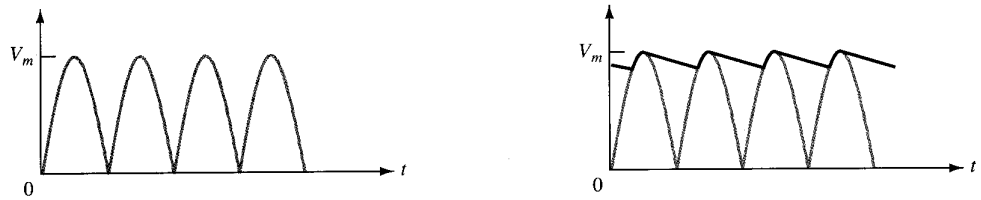

FIGURE 10.2 - WAVE FORMS (1)

10.3 FIGURE 10.3 shows a circuit containing two diodes that are used as rectifiers.

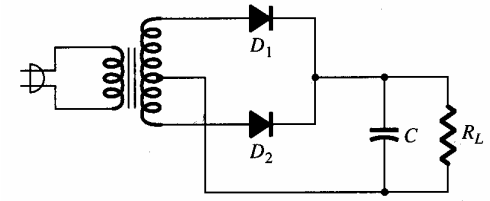

FIGURE 10.3 - CENTRE TAP RECTIFIED CIRCUIT

10.3.1 Draw the output wave form of the circuit. (2)
10.3.2 Draw the output wave form if the capacitor should be removed from the circuit. (1)
10.3.3 Is this circuit a regulated circuit? Motivate your answer. (2)

10.4 FIGURE 10.4 illustrates a series-regulated power supply.

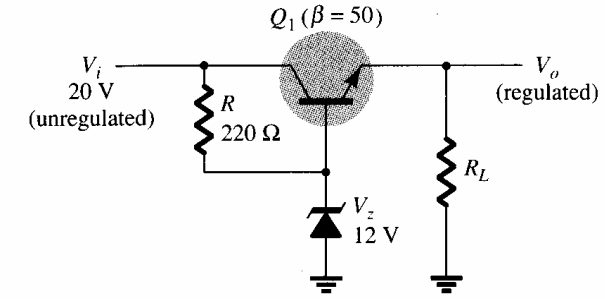

FIGURE 10.4 - SERIES-REGULATED POWER SUPPLY

10.4.1 Calculate the exact output voltage of the circuit. (2)
10.4.2 Calculate the current through the Zener diode. (5)
[15]

QUESTION 11: LOGIC CIRCUITS

11.1 The logic circuit in FIGURE 11.1 shows four logic gates. Make use of your knowledge of logic circuits to determine the Boolean algebra equation of the output of the circuit.

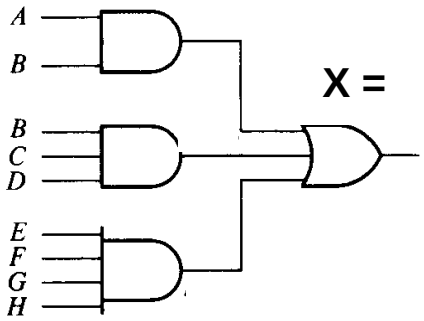

FIGURE 11.1 - LOGIC CIRCUIT (5)

11.2 Design a logic circuit that will satisfy the Boolean algebra equation stated below.

$$Y = \overline{(A.B) + (C.D)}$$ (4)

11.3 FIGURE 11.2 shows the input and output wave forms of a logic circuit. Use your knowledge of positive logic gates to develop the truth table as well as the Boolean equation of the circuit. (8)

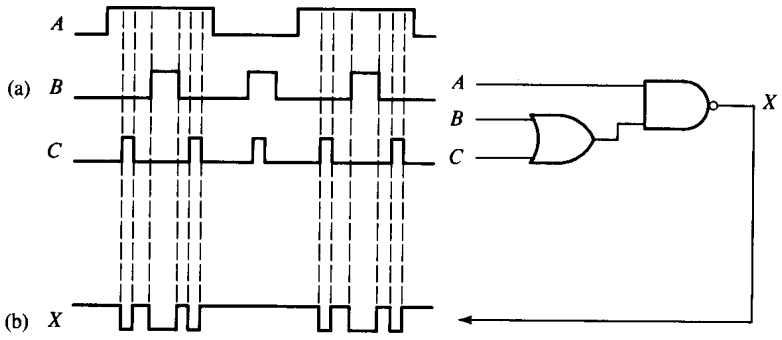

FIGURE 11.2 - POSITIVE LOGIC CIRCUIT WITH OUTPUT

11.4 In logic circuits, what will be the function of the clock pulse? (1)

11.5 Determine the logic gate for the truth table in FIGURE 11.3.

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

FIGURE 11.3 - TRUTH TABLE (2)

[20]

QUESTION 12: PROTECTIVE DEVICES

12.1 Describe the functions of:

12.1.1 An earth-leakage relay unit (3)

12.1.2 A circuit-breaker (3)

12.2 Explain TWO advantages of a circuit breaker when it is compared to a fuse. (2)

12.3 Describe the main function of a fuse. (2)

[10]

QUESTION 13: OPERATING PRINCIPLE OF SINGLE-PHASE MOTORS

Mr Beucke uses an electrical lawn mower to mow his lawn. The lawn mower no longer starts when it is connected to the supply but when the blades are rotated (while connected to the supply), it starts to rotate by itself. Upon inspection of the motor, it is found that there is a capacitor attached to the frame of the motor and connected to the motor. The name plate of the motor indicates that the motor is a 220 V/50 Hz single-phase motor.

Answer the following questions:

13.1 Identify the type of single-phase motor used in the machine (1)

13.2 Explain the purpose of the capacitor that is connected to the motor (2)

13.3 Describe the problem that causes the motor not to run (2)

13.4 Explain the purpose of the centrifugal switch used in single-phase motors (2)

13.5 Draw a simple, labelled diagram of a single-phase capacitor-start capacitor-run motor (6)

13.6 Explain how the direction of rotation of each of the following motors can be changed:

13.6.1 Universal motor (2)
13.6.2 Split phase motor (2)

13.7 Explain the difference between rotor speed and synchronous speed. (4)

13.8 Identify practical situations where the following motors can be used:

13.8.1 Universal motor (2)
13.8.2 Split phase motor (2)
[25]

QUESTION 14: COMMUNICATION SYSTEMS

14.1 FIGURE 14.1 indicates a simple process that takes place in receivers. The diode acts as a detector in this instance. Name the process that took place.

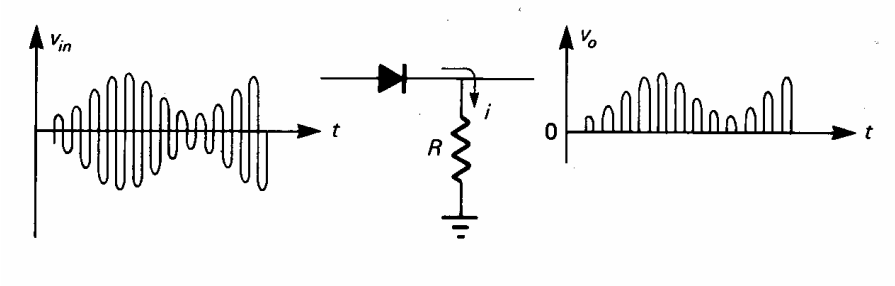

FIGURE 14.1 - BASIC DIODE DETECTOR CIRCUIT (1)

14.2 In FIGURE 14.2 a capacitor is added to the output. Explain the purpose of the capacitor in this instance.

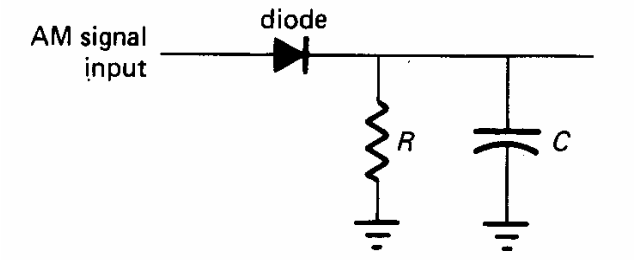

FIGURE 14.2 - DIODE DETECTOR CIRCUIT WITH CAPACITOR (1)

14.3 FIGURE 14.3 below shows the circuit diagram of a mixer that mixes/combines the frequencies detected from the local oscillator as well as the radio frequency oscillator.

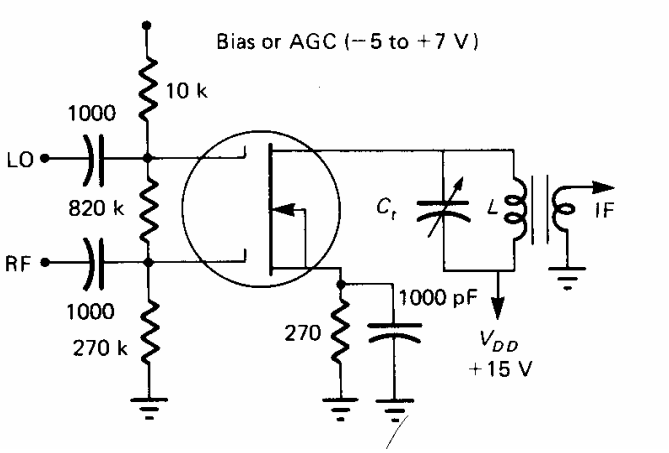

FIGURE 14.3 - MIXER CIRCUIT

Determine the output frequencies that will be fed to the Intermediate Frequency (IF) stage if the frequency from the local oscillator is 10,7 MHz and the RF signal being fed into the mixer is 3,7 MHz. This is the frequency where amateur radio operators play music for test purposes. (2)

14.4 An AM receiver uses a demodulator in the receiver phase. State the correct term for the exact same stage in an FM receiver. (1)

14.5 FIGURE 14.4 shows how a radio signal is transmitted in the high frequency spectrum, for instance 14,200 MHz where amateur radio operators talk over distances of thousands of kilometres. This wave is propagated through sky wave propagation as shown below.

Explain why stations that are in the skip zone of the sky wave propagation will not detect any of the signals being transmitted in their direction.

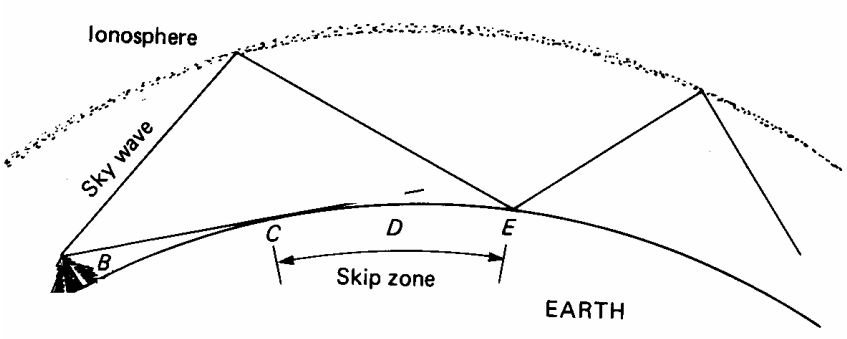

FIGURE 14.4 - SKY-WAVE PROPAGATION (2)

14.6 Sometimes a television receiver has a ghost picture despite it being brand new and in working condition. (A television ghost picture is when it seems like a second picture is also being depicted on the screen, although it is weak.)

Make use of the FIGURE 14.5 to explain this phenomenon.

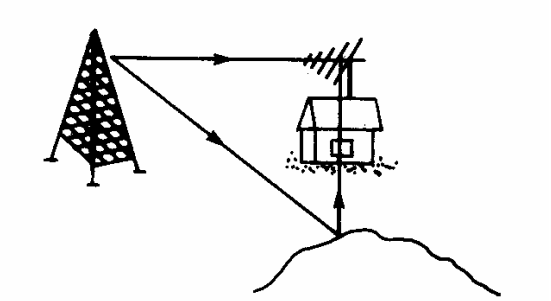

FIGURE 14.5 - TELEVISION SIGNAL PATHWAY (2)

14.7 Do cellular phones incorporate any form of radio transmitters? (1)

[10]

TOTAL: 200

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

$$e = EmSin\theta$$

$$\omega = 2\pi F$$

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

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

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

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

$$X_L = 2\pi FL$$

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

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

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

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

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

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

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

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

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

$$S = Vp \times Ip$$

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

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

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

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

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

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

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

END