**GAUTENG DEPARTMENT OF EDUCATION**
**SENIOR CERTIFICATE EXAMINATION**

**TECHNIKA (ELECTRONICS) HG**

**FEB / MAR 2006**

**TIME: 3 hours**

**MARKS: 300**

**INSTRUCTIONS:**

- Answer ALL the questions.
- Sketches and diagrams must be large, neat and labelled.
- All calculations must be shown.
- Answers must be clearly numbered according to the numbering used on the question paper.
- A formula sheet (pages 11 – 13) is provided at the end of the paper.

## QUESTION 1
## ELECTRIC CURRENT THEORY

1.1 Refer to **Figure 1.1** and calculate the voltage drop across $X_{L2}$.

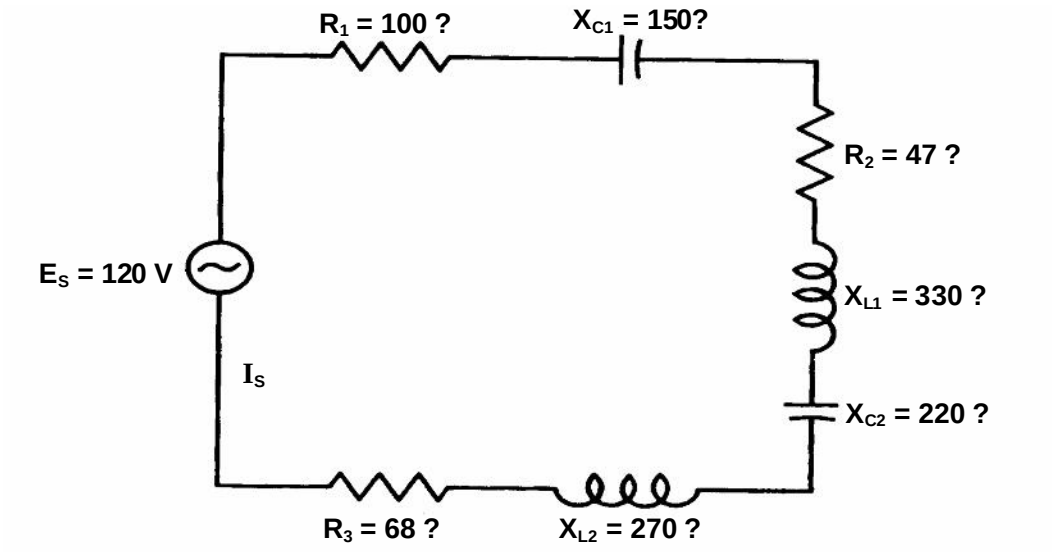



**Figure 1.1: Multi-element Series RLC Circuit** (12)

1.2 The reactances of **L** and **C** are frequency dependent. Use a neat, labelled frequency to reactance response curve to illustrate the effect resonant frequency has on the reactances of **L** and **C**. (5)

1.3 Calculate the value of the capacitance required to resonate the secondary winding of an FM receiver's intermediate-frequency (IF) transformer if Fr = 10,7 MHz and L = 23 $\mu$H. (5)

1.4 In the transfer of maximum power from a source to a load, the load impedance must equal the internal impedance of the source. Calculate the effective resistance (internal impedance) of a source, if the impedance-matching transformer has a turn-ratio of 25:1 and is connected to an output load of 16 ?. (5)
**[27]**

## QUESTION 2
## SEMICONDUCTOR DEVICES

2.1 Identify the following electronic components with reference to the electronic circuit diagram in **Figure 2.1**. For example: R1 is a 330 ? resistor.

2.1.1 TR2 (2)
2.1.2 D3 (2)
2.1.3 D1 (2)
2.1.4 LS1 (2)
2.1.5 C1 (3)

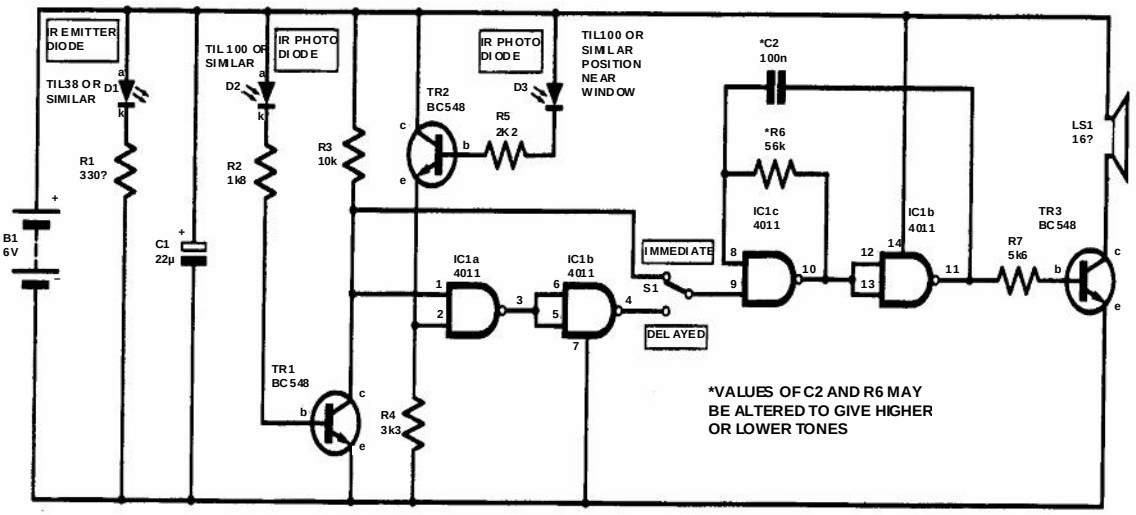



**Figure 2.1: Electronic alarm circuit**

2.2 Explain by means of neat, labelled sketches and a brief description, the **basic construction** and **functional** operation of the **uni-junction transistor (UJT)**. Your explanation should include a characteristic curve. (20)

2.3 If a silicon-controlled rectifier (SCR) is switched on, it will continue to conduct even if the gate potential is removed (with reference to DC circuits). Explain, by means of a neat, labelled circuit diagram and a brief explanation TWO methods to turn an SCR off. (8)

**[39]**

## QUESTION 3
## AMPLIFIERS

3.1 Design a DC bias circuit for an amplifier as shown in **Figure 3.1**. The manufacturer's specifications state that the transistor has a current gain of 200, typical, at a collector current of 1 mA, and a supply voltage of 25 Volt. (20)

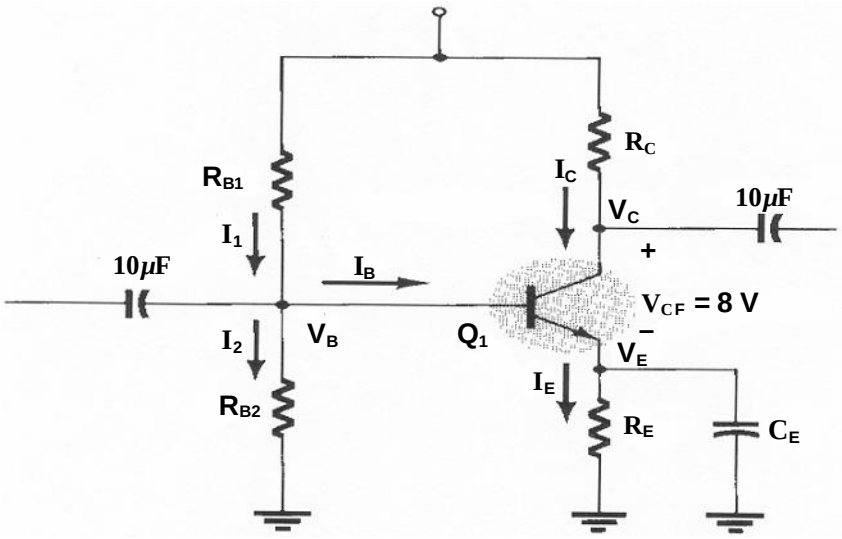



**Figure 3.1: Common-emitter Amplifier**

3.2 To amplify a signal to a level adequate to drive an antenna, several stages of amplification are required. Explain with the aid of a neat, labelled diagram and a brief description, the principle of operation of the multi stage radio-frequency (RF) amplifier. (20)

**[40]**

## QUESTION 4
## SWITCHING AND CONTROL CIRCUITS

4.1 Design a circuit that will automatically switch on a light as darkness falls and will switch it off again at dawn. (10)

4.2 **Figure 4.1** illustrates a burglar alarm with buffer circuitry. Explain the working principle of this circuit, with specific reference to the value of the buffer circuit. (10)

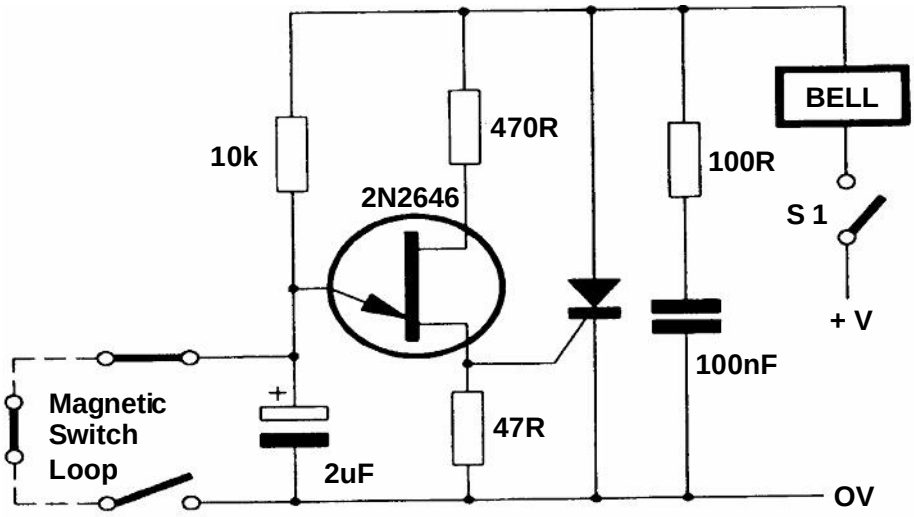
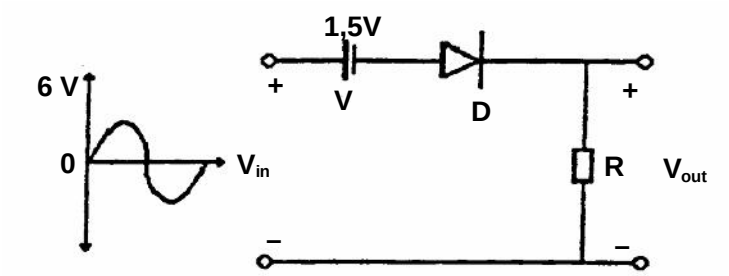



**Figure 4.1: Alarm with Buffer Circuitry**

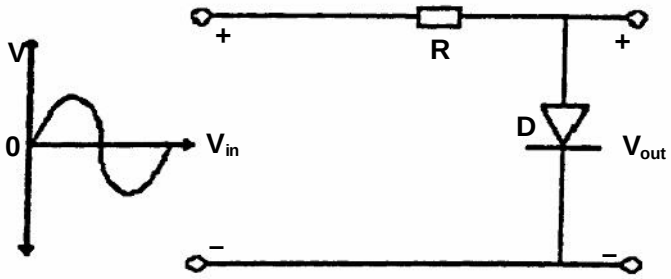
4.3 Clippers and clampers are diode wave-shaping circuits transmitting parts of waves and suppressing others to a predetermined value. Find the output-voltage wave shapes for the inputs shown in **Figure 4.3** (Sketch only the output-voltage wave shapes in your answer book.)

4.3.1



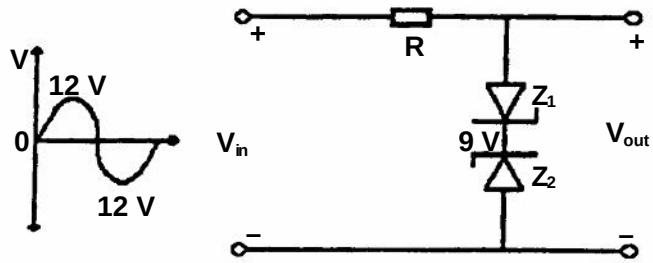

(4)

4.3.2



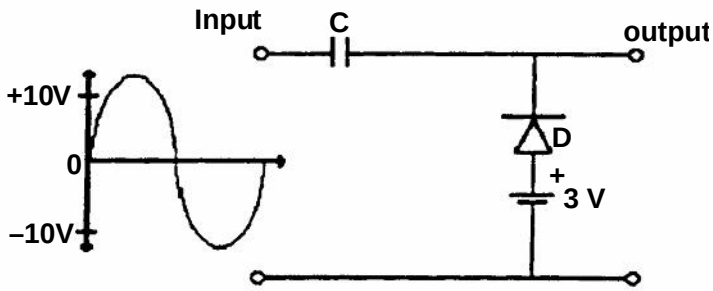

(3)

4.3.3




(4)

4.3.4




(4)

**Figure 4.3: Wave-shaping Circuits**

4.4 Explain the working principle of **ANY** electronic experiment **OR** model that you have built / designed this year. Note that your explanation should include a neat, labelled circuit diagram or block diagram with a brief description. All wave forms, where applicable, should be included. Please note that the description should directly link to your circuit diagram. You are not allowed to replicate any question or circuit already covered in this question paper. (15)
**[50]**

## QUESTION 5
## OSCILLATORS

5.1 Explain with the aid of a neat, labelled circuit diagram and brief description, the operating principle of a crystal-controlled Hartley oscillator. (15)

5.2 When a feedback signal is connected in order to add to the input signal applied, a circuit could be driven as an oscillator. Name THREE advantages of negative feedback. (3)
**[18]**

## QUESTION 6
## COMPUTER PRINCIPLES

6.1 Refer to **Figure 6.1** and determine the truth table of the logic circuit. Identify the logic circuit.

Note: 74LS00 is an inverter.

74LS08 is an AND gate.

74LS32 is an OR gate. (7)

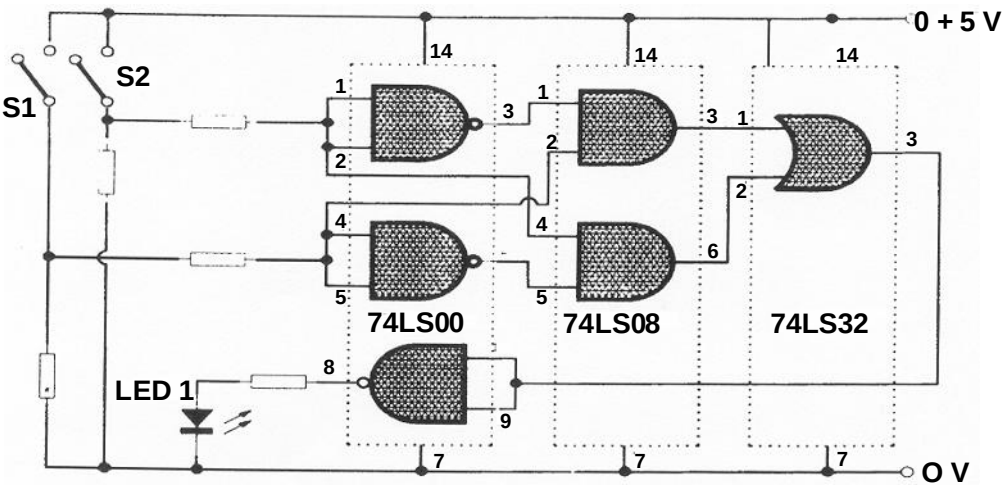



**Figure 6.1: Logic Circuit**

6.2 Prove by means of Boolean-algebra that:

$$A\ B\ \overline{C} + A\ \overline{B}\ \overline{C} + A\ \overline{B}\ C + A\ B\ \overline{C} + A\ B\ C + \overline{A}\ B\ C = A + B \quad (7)$$

6.3 An electric light is to be controlled by three switches. The light is to be on whenever switches **A** and **B** are in the same positions. When switches **A** and **B** are in different positions, then the lights are to be controlled by switch **C**.

6.3.1 Draw up a truth table for this situation and represent the function **F** in terms of **A**, **B** and **C**. (8)

6.3.2 Simplify the function and design a practical logic circuit. (9)

6.4 Add the following two numbers in binary:

28,375

\+ 9,00

(4)

6.5 Illustrate by means of a neat, labelled block diagram of a full-adder circuit, how the following binary numbers will be added. (16)

1011

\+ 110

**[51]**

## QUESTION 7
## INFORMATION TRANSFER

7.1 Illustrate the principle of operation of the FM transmitter using a neat, labelled block diagram. (8)

7.2 Name THREE major causes of signal loss in fibre-optic cable splices. (6)

7.3 Explain by means of a neat, labelled block diagram the basic working principle of a typical microwave communication link. (12)

7.4 Explain the purpose of the repeater in your block diagram with reference to Question 7.3. (5)

**[31]**

## QUESTION 8
## MEASURING INSTRUMENTS

8.1 Illustrate by means of a neat, labelled block diagram the basic operating principle of a digital voltmeter. (12)

8.2 List TWO typical adjustable controls on a cathode-ray oscilloscope (CRO). (2)

8.3 Explain the purpose of the time-base generator in an oscilloscope. (2)

8.4 Examine **Figure 8.1**. What voltage is indicated on the analogue-meter if the range selector switch is on 30? (2)

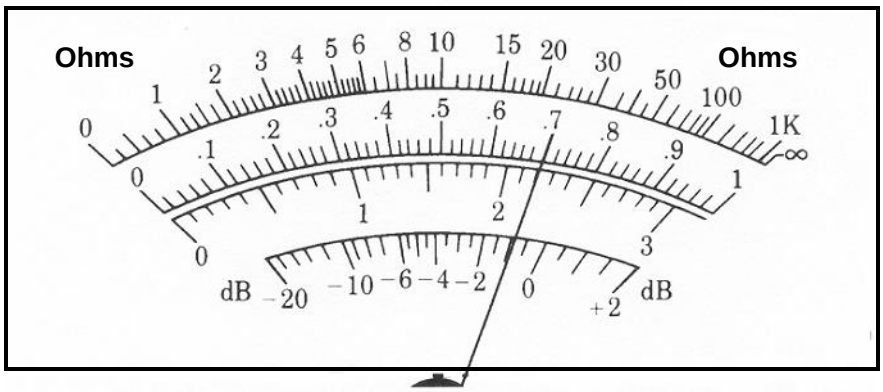



**Figure: 8.1 Analogue-meter Reading**

8.5 Examine **Figure 8.2**.

8.5.1 Determine the peak-to-peak voltage of the wave if the Volts / Division switch is on 2mV / Division. (3)

8.5.2 Determine the frequency if the Time / Division setting of the oscilloscope is set at 1 (one) µSec/Div. (6)

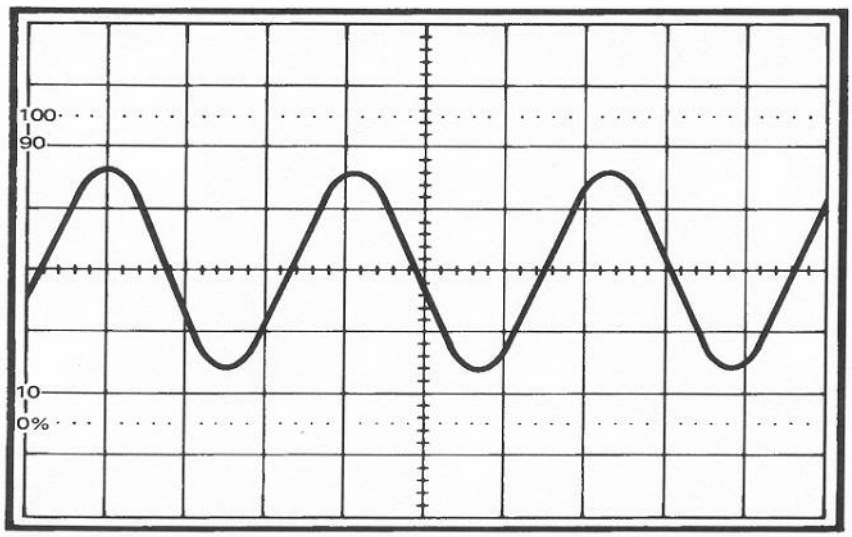



**Figure 8.2: Waveform** **[27]**

## QUESTION 9
## SAFETY PRECAUTIONS

9.1 Name THREE precautions that should be taken into account when using a multimeter. (3)

9.2 What is **NOSA**? (2)

9.3 For each type of fire extinguisher listed in the table below, write down only the question number and the class of fire for which you would use each. (3)

| CLASS OF FIRE | TYPE OF FIRE EXTINGUISHER |
|---|---|
| 9.3.1 | Water |
| 9.3.2 | Foam |
| 9.3.3 | Dry Powder |

9.4 Answer the following questions by writing TRUE or FALSE next to the appropriate question number in your answer book.

A person can contract Aids from

9.4.1 kissing an HIV infected person. (1)

9.4.2 working with an HIV infected person. (1)

9.4.3 donating blood. (1)

9.4.4 having a blood transfusion. (1)

9.4.5 sharing the same toilet facilities with a person who is infected with HIV. (1)

9.4.6 having unprotected sex. (1)

9.4.7 using the same cutlery as an HIV infected person. (1)

9.5 Write down the Aids hotline number. (2)

**[17]**

**TOTAL: 300**

## INFORMATION SHEET / *INLIGTINGSBLAD*

## ELECTRIC CURRENT THEORY / *ELEKTRIESE STROOMTEORIE*

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

$$P = V \times I \text{ WATT}$$

$$t = \frac{1}{F} \text{ seconds / } \textit{sekondes}$$

$$V_{ave.} / _{gem.} = V_m \times 0{,}637$$

$$V_{mms./ wgk.} = V_m \times 0{,}707$$

$$X_C = \frac{1}{2 \times p \times f \times C}$$

$$X_L = 2 \times p \times f \times L$$

$$V_T = \sqrt{V_R^{\,2} + V_C^{\,2}}$$

$$V_T = \sqrt{V_R^{\,2} + V_L^{\,2}}$$

$$V_T = \sqrt{V_R^{\,2} + V_X^{\,2}}$$

$$V_X = V_L - V_C$$

$$f_r = \frac{1}{2 \times p \times \sqrt{LC}}$$

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

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

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

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

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

$V_C = I_T \times X_C$

$V_L = I_T \times X_L$

$V_R = I_T \times R$

$V_T = \sqrt{V_R^2 + V_X^2}$

$V_X = V_C - V_L$

$I_T = \sqrt{I_R^2 + I_X^2}$

$I_X = I_C - I_L$

$\frac{N_1}{N_2} = \sqrt{\frac{Z_1}{Z_2}}$

$Z = \sqrt{R^2 + X_C^2}$

$Z = \sqrt{R^2 + X_L^2}$

$Z = \sqrt{R^2 + X_X^2}$

$X_X = X_L - X_C$

## AMPLIFIERS / *VERSTERKERS*

$I_e = I_c + I_b$

$V_{cc} = V_{Rc} + V_{ce}$

$V_e \cong \frac{1}{10} V_{cc}$

$I_c = \frac{V_{cc}}{Rc}$

## DECIBEL RATIOS / *DESIBEL-VERHOUDINGS*

$$G_I = 20 \text{ LOG } \frac{I_2}{I_1}$$

$$G_V = 20 \text{ LOG } \frac{V_2}{V_1}$$

$$G_P = 10 \text{ LOG } \frac{P_2}{P_1}$$

## OPERATIONAL AMPLIFIERS / *OPERASIONELE VERSTERKERS*

$$A_V = -\frac{R_F}{R_1}$$

$$V_{OUT} = A_V \times V_I$$

$$A_V = 1 + \frac{R_F}{R_1}$$

$$V_{OUT} = A_V \times V_I$$

$$V_{OUT} = \frac{1}{RC}\int V_1 \, dt$$

$$V_{OUT} = -RC\frac{dv}{dt}$$

$$V_{OUT} = -\left(V_1\frac{R_F}{R_1} + V_2\frac{R_F}{R_2} + V_3\frac{R_F}{R_3}\right)$$

## COMPUTER PRINCIPLES / *REKENAARBEGINSELS*

$A.B = B.A$
$A + B = B + A$

$A.(B.C) = (A.B).C$
$A + (B + C) = (A + B) + C$

$A.(B + C) = AB + AC$
$A + (B.C) = (A + B) + (A + C)$

$A(A + B) = A$
$A + (AB) = A$

$A + 0 = A$
$A + 1 = 1$
$A.0 = 0$
$A.1 = A$
$A + \underline{A} = A$
$A + A = 1$
$A.\underline{A} = A$
$A.A = 0$

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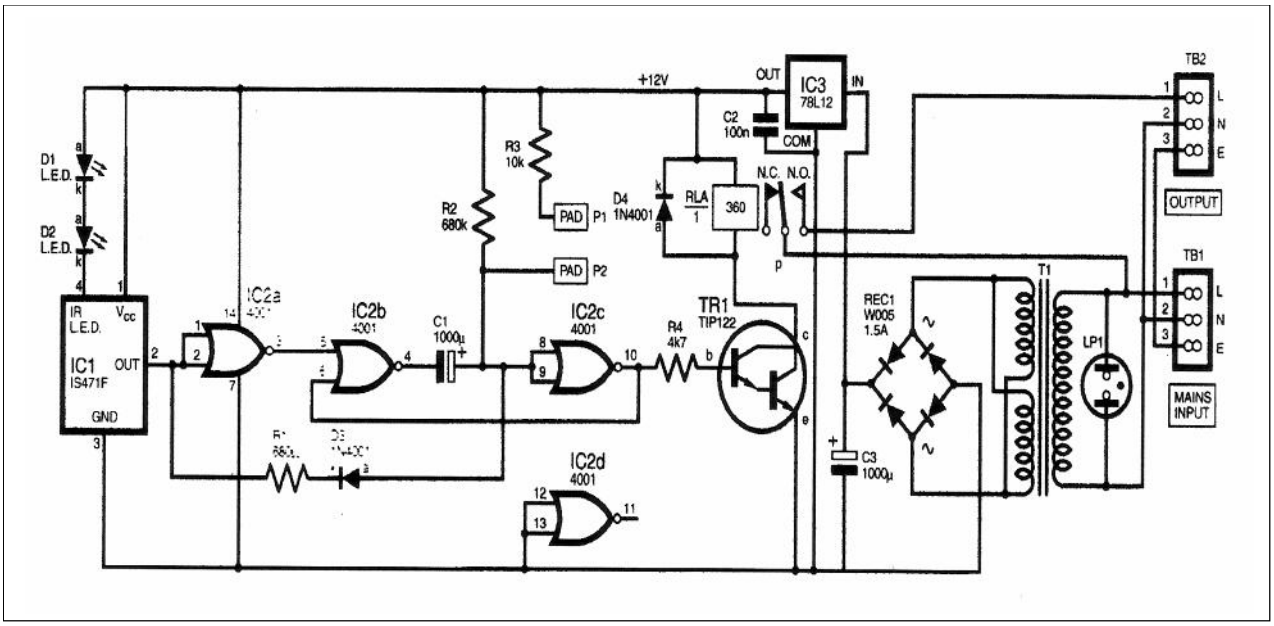
new drawing

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