NATIONAL BUSINESS AND TECHNICAL EXAMINAT IONS BOARD NATIONAL TECHNICAL CERTIFICATE EXAMINATION

BASIC ELECTRICITY

Question 1 (a) List three sources of heat in soldering

(b) state the functions of flux in soldering

(c) briefly describe with aid of diagram how a 13A plug could be connected to a length of 3* $1.5mm^2$ flexible cable. Show the detailed connections at the terminals.

SOLUTION

(a) Three sources of Heat in soldering

(i) Electricity

(ii) Gas and

(iii) Blow lamp

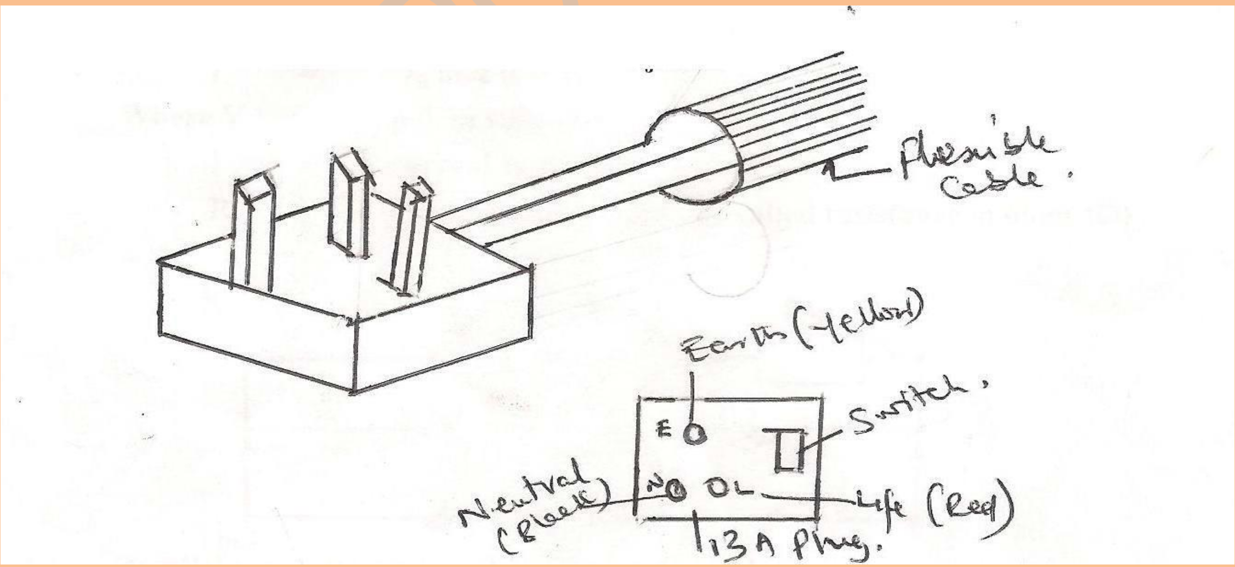
(b) Three functions of fluxes in soldering

(i) They serve as cleaning agent

(ii) They prevent oxidation/corrosion

(iii) To avoid dry Joints

(iv) For easy flow of solder over the joints



(c) The flexible cables are usually three in a cord of wire which is marked with the following colours, Red; black and Yellow. It is of different diameters but this very one is of 1.5mm^2 each. This is connected to a 13A plug that has three terminals.

The red cable is connected to the life terminal of the plug, the black is connected to the neutral terminal of the same plug while the yellow cable is connected to the Earth terminal of the plug. This explanation has been further described in the above diagram.

QUESTION 2 (a) State Ohm's law

(b) Two resistors in parallel., A of 20Ω and B of 40Ω are connected to a length of another resistor C of value 15Ω. If the supply to the circuit is 200V d.c. Calculate

(i) Total resistance of the parallel group
(ii) Total resistance of the circuit
(iii) The supply current
(iv) Current in the 20Ω resistor
(v) Voltage drop in the 15Ω resistor

SOLUTION

(a) Ohm's law states that the electric current (strength or intensity) flowing in a conductor or wire in a closed (dc) circuit is directly proportional to the p.d. between its ends; provided the temperature and other physical factors are constant. OR that, the electric current is directly proportional to the p.d and inversely proportional to the resistance provided the temperature and other physical factors remain constant.

i.e. $V \alpha I$

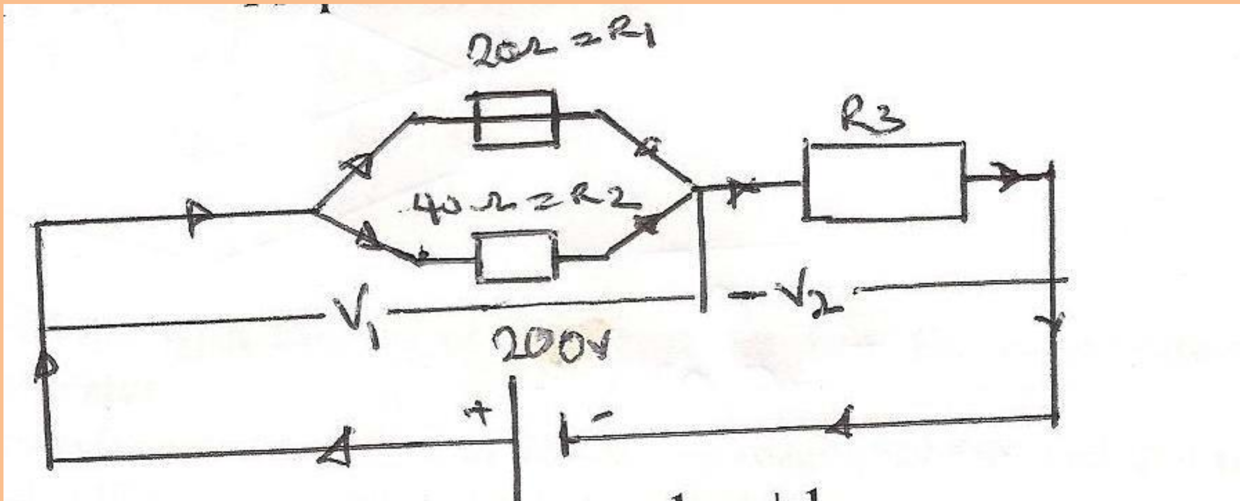
$\Rightarrow V = IR$

$I = {}^{V}/_{R}$ and $R = {}^{V}/_{I}$

Where V = p.d. in volts (V)

I = current in Ampere (A) and

R = Proportionality constant called resistance in ohms (Ω)



(i) Parallel group Resistance, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_P} = \frac{1}{20} + \frac{1}{40}$

$\frac{1}{R_P} = \frac{2+1}{40} = \frac{3}{40}$

$\Rightarrow \quad R_P = \frac{40}{3} = 13.33\Omega$

Total Resistance in the circuit

$R_T = R_P + R_3$

$= 13.33 + 15$

$= 28.33\Omega$

(i) The supply current I_T

$I_T = \frac{V}{R_T}$

$= \frac{200}{28.33}$

$I_T = 7.06A$

(iv) Current in 20Ω resistor

The p.d. across 15Ω = $I_T R_1 = V_1$

But $V_2 = 15 \times 7.06$

$= 105.9V$

$\Rightarrow V_1 = 200 - V_2$

$= 200 - 105.9$

$= 94.1V$

But $V_1 = I_1R_1$

$$\Rightarrow I_1 = \frac{V_1}{R_1} = \frac{94.1}{20.0}$$

$= \underline{4.70}A$

(v) Voltage drop in the 15Ω Resistor (R_3)

$V_2 = I_T \times R_3$

$= 7.06 \times 15$

$= \underline{\underline{1}}05.9V$

Question 3

(a) Briefly describe with the aid of a labeled diagram the construction of an auto-transformer

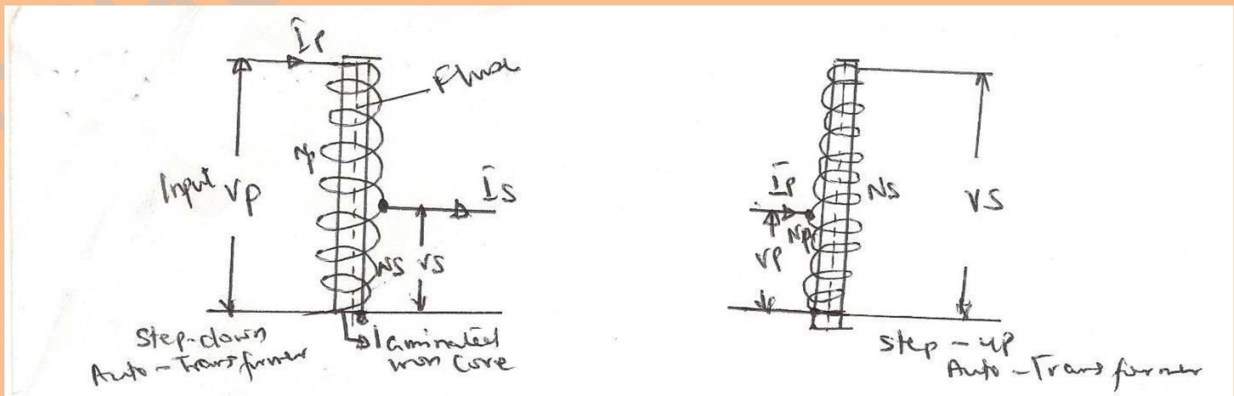
(b) An auto-transformer has a coil at 750 turns, tapped at 500 and 450 turns. If a supply of 240V ac is connected between the common terminals and the tapping is at 500 turns. Calculate the induced emf between the common terminals and

(i) the tapping at 450turns

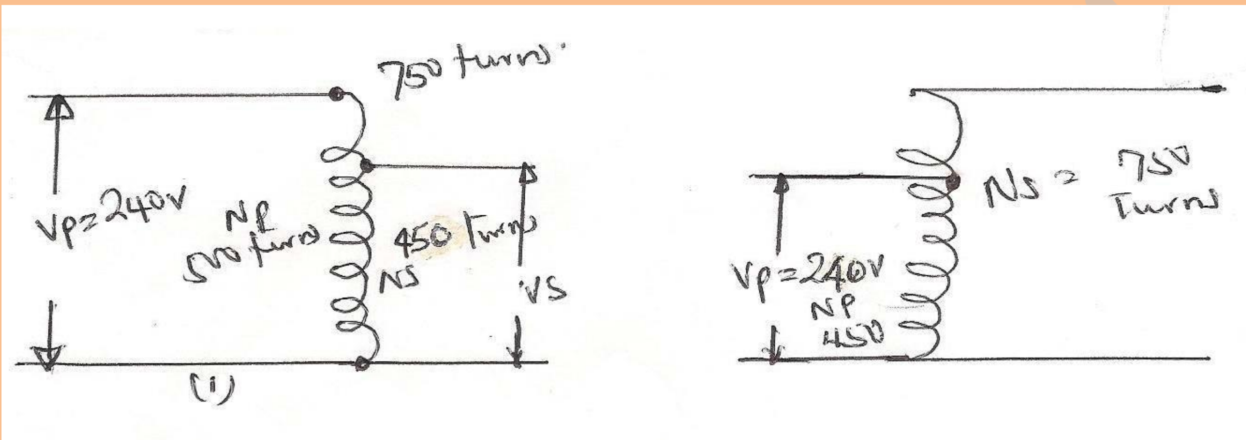
(ii) the tapping at 750turns

Solution

3(a) The auto-transformer is of two types; the step-down and step-up autotransformers. In the auto-transformer, there is only one winding which has one or more tapping points. This winding serves as both primary and secondary windings. The basic connections for the step-down and step-up transformers are as shown in the diagrams below.



The auto-transformer is less expensive than the double-wound transformer but its use is limited because of the danger inherent in the direct electrical connections which exist between the input and output terminals. Auto-transformers are often employed in Ac motor-starters to reduce the pressure applied to the motor during the starting period.



(3b). V_p = Primary voltage

V_s = emf induced between the common terminal (secondary)

N_p = number of primary turns

N_s = number of secondary turns

From $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

$\frac{240}{V_s} = \frac{500}{N_s}$

$V_s = \frac{240 \times 450}{500} = 108000$

$= \underline{216V}$

$\frac{V_p}{V_s} = \frac{Np}{N_s}$

$\frac{240}{V_s} = \frac{500}{750}$

$V_s = \frac{240 \times 750}{500} = \frac{180000}{500}$

$= \underline{360V}$

Question 4

(a) Briefly explain the following terms in relation to measuring instruments. (i) operating device (ii) damping device (iii) controlling device

(b) A moving coil instrument having a coil of resistance 100Ω requires a current of 1MA to give full scale deflection. Determine the values of the series resistors required so that the instrument will have a range of

(i) 0 – 50V

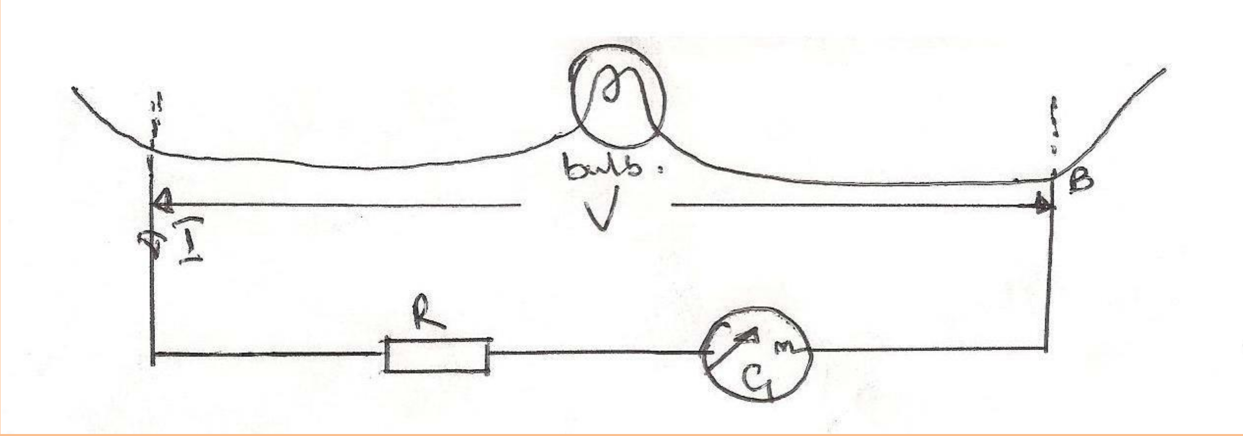
(ii) 0 – 200V

Solution

4(a) (i) Operating Device: When the current to be measured is fed into and out of the coil an electronmagnetic filed is produced and this interacts with the field produced by the permanent magnet. This action causes the pointer to rotate to produce operating torque that returns the coil to the zero position.

(ii) Controlling Device: The controlling device is also known as restoring device. This device balances the operating torque when the instrument pointer is not at the correct deflection. There are two types of controlling devices, namely gravity control device and spring control device.

(ii) Damping Device: The damping device is used to prevent oscillation of the moving system and this enables the moving system to reach its final position quickly.



(b) p.d. across AB = 50V

Current I = 1mA = 0.001A

Resistance = R + r

p.d across R = IR = 0.001R

p.d across r in Galvo = Ir = 0.001 x 100

= 0.1

Total p.d across AB = p.d across R + p.d. across Galvo (R)

50V = 0.001R + 0.1

0.001R = (50 – 0.1)V

0.001R = 49.9

$R = \frac{49.9}{0.001} = 49900\Omega$

$\therefore R_{50} = 49900\Omega$]\

(ii) Total p.d. across AB = 200V

200V = p.d across R + p.d across Galvo (r)

200V = 0.001R + 0.1V

0.001R = (200-0.1)V

0.001R = 199.9

$\Rightarrow R = \frac{199.9}{0.001}$

$\therefore R_{200} = 199900\Omega$

Question 5 (a) Define a capacitor

(b) List FOUR types of capacitor

(c) Three capacitors of values 10μF, 15μF and 45μF respectively are connected in

i. Series

ii. Parallel

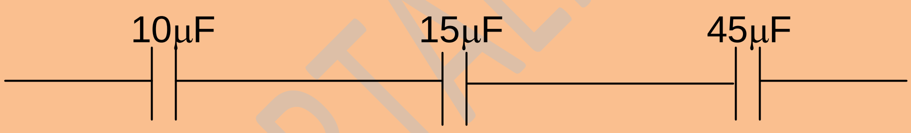
Solution

5(a) A capacitor is a device which is designed to store electric charges. The ability of the capacitor to store electric charges is known as capacitance. Most capacitors have breakdown voltage i.e. the maximum voltage which should be applied across a capacitor. Malfunction will occur if the breakdown voltage is exceeded. The power factor and the stability of a capacitor must not be ignored when making choice.

(b) FOUR types of capacitors

(i) Polystyrene capacitor
(ii) Ceramic capacitor
(iii) Paper capacitor
(iv)
(iv) Electrolytic capacitor
(v) Tantalum capacitor
(vi) Silver mica capacitor

(c) i Series



$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$= \frac{1}{10} + \frac{1}{15} + \frac{1}{45}$$

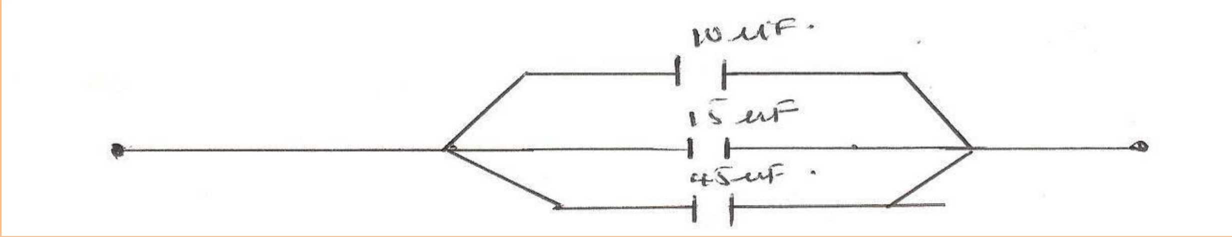
$$= \frac{9 + 6 + 2}{90} = \frac{17}{90}$$

$$\frac{1}{C} = \frac{17}{90}$$

$$\Rightarrow C = \frac{90}{17} = 5.29\mu F$$

$$\therefore C_S = 5.29\mu F$$

(ii) Parallel



$C = C_1 + C_2 + c_3$

$= 10 + 15 + 45$

$C_p = (10 + 15 + 45)\mu F$

$= 70\mu F$

Question 6

(a) Explain the meaning of the following terms in connection with alternating current

(i) Inductance

(ii) Capacitance

(iii) Reactance

(iv) Impedance

(b) A coil of inductance 0.05H is connected in series with a 20μF capacitor. calculate

(i) the inductive Reactance pf the circuit

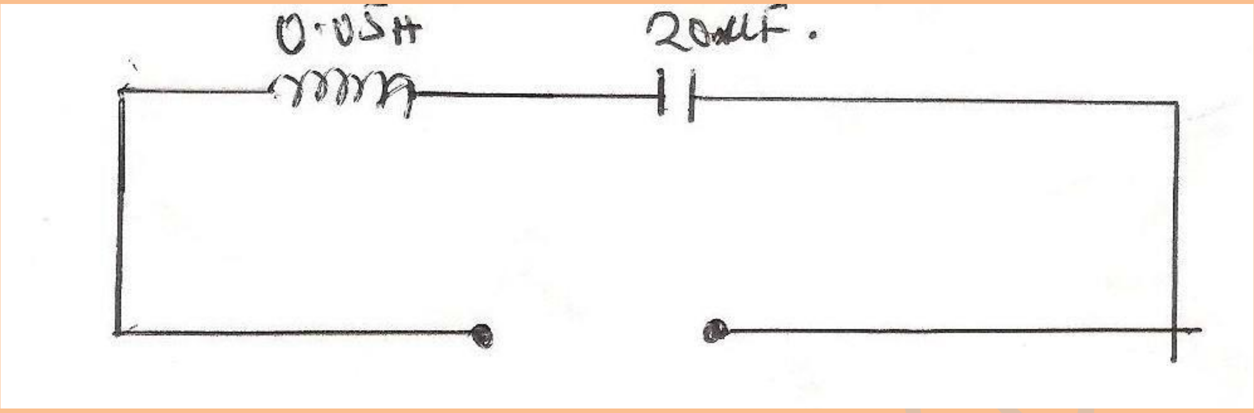
(ii) the resonance frequency.

Solution

6(a) (i) Inductance:

Inductance could be self or mutual. It occurs when a change in current of a closed circuit causes a change of flux and thereby producing an induced emf in the circuit or coil. This phenomena is referred to as inductance. It is self inductance if the phenomena happens in a single coil or circuit but if two coils or circuits are involved such that a change in current in one coil lead to a corresponding change of flux liking with the other coil thereby producing an induced emf in the second coil, the phenomena is called mutual inductance. The inductance is measured in Henry (H).

6b



(ii) $X_L = 2\bar{\Lambda}fL$, $X_c = \frac{1}{2\bar{\Lambda}fc}$

At Resonance

$X_L = X_c$

$2\bar{\Lambda}fL = \frac{1}{2\bar{\Lambda}fc}$

$f^2 = \frac{1}{4\bar{\Lambda}^2LC}$

$f = \sqrt{\frac{1}{4\bar{\Lambda}^2LC}}$

$= \sqrt{25330.29}$

$= 159.155Hz$

(i) Inductive Reactance

$X_L = 2\bar{\Lambda}fL$

$= 2x3.142x159.155x0.05$

$= 50\Omega$

(ii) Capacitance:

The ability of a capacitor to store electric charge is known as the capacitance of the capacitor. Capacitance of a capacitor is symbolized by a letter C and it is measured in Farad (F). The capacitance of a capacitor depends on three main factors namely.

(i) Area of the plates
(ii) The nature of di-electric used and

(iii) The gap between the plates. Capacitance is measured in Farad (F)

(iii) Reactance

Reactance in an Ac circuit is of two kinds; the inductive and capacitive reactances. Reactance(x) is the opposition offered to an alternating current due to the presence of an inductor or capacitor in the circuit.

Capacitive Reactance is given as X_c

Where $X_c = \frac{1}{2\bar{\Lambda}fc}$

Inductive Reactance is given as X_L

Where $X_L = 2\bar{\Lambda}fc$

Reactance is measured in ohms (Ω)

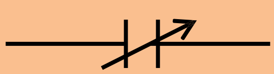
(v) Impedance

Impedance as used in an A.C circuit is the total or effective opposition offered to a A.C. due to the presence of inductor (Inductance coil) a capacitor and a resistor in an A.C. circuit. The impedance is measured in Ohms (Ω) and represented as Z.

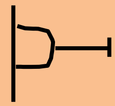
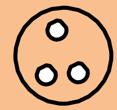
Where $Z = \sqrt{R^2 + X_L^2}$ Or $\sqrt{R^2 + X^2_c}$ OR $\sqrt{R^2 + (X_L - X_c)^2}$

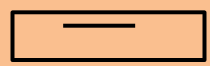
Question 7 Draw the B.S. graphical symbols of the following

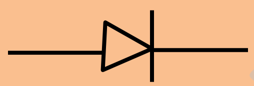
(i) Resistor  or 

(ii) Variable Capacitor 

(iii) Coil

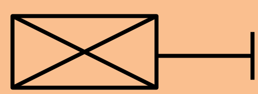
(iv) 15A socket  or  

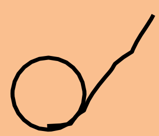
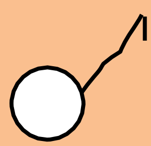
(v) Ceiling regulator 

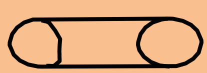
(vi) Diode  or 

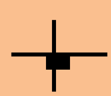
(vii) Transformer

(viii) Buzzer 

(ix) cooker control unit 

(x) One way switch  or 

(xi) Fuse link 

(xii) Soldered joint  or