NATIONAL BUSINESS AND TECHNICAL EXAMINAT IONS BOARD NATIONAL TECHNICAL CERTIFICATE EXAMINATION

Question 1

BASIC ELECTRICITY

(a) State the symbol and the numerical meaning of the following:

(i) Pico

(ii) Micro

(iii) Milli

(iv) Mega

(v) Kilo

b. A 400μF capacitor is charged by a steady current of 0.4A Flowing for 6 seconds.

(i) Calculate the final value of the charge stored in the capacitor and the p.d between it's plates.

(ii) If the capacitor is subsequently discharged in 60 micro seconds.

Calculate the average discharged current.

Solution

a. (i) Pico = P (10^{-12})

(ii) Micro = $\mu(10^{-6})$

(iii) Milli = $m(10^{-3})$

(iv) Mega = $M(10^{6})$

(v) Kilo = $K(10^{3})$

b. (i) $Q = CV$

$Q = It$

$= 0.4 \times 6$

$= \underline{2.4C}$

$Q = CV$

$V = \frac{Q}{C} = \frac{2.4}{400 \times 10^{-6}}$

$= \frac{2.4 \times 10^{6}}{400}$

$= \cancel{6,000}$

$= 6 \times 10^{3}$ V or $\underline{6KV}$

(ii) If $V = 6 \times 10^{3}\ V$

$Q = CV$

$It = 400 \times 10^{-6} \times 6 \times 10^{3}$

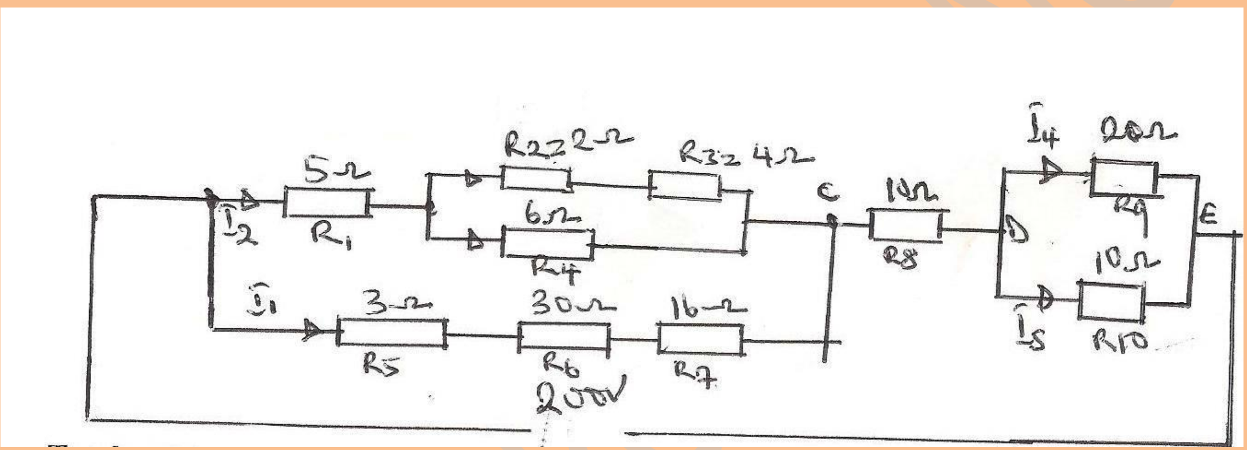
$I \times 60 \times 10^{-6} = 400 \times 10^{-6} \times 6 \times 10^{3}$

$I = \dfrac{400 \times 6 \times 10^{3}}{60}$

$I = \underline{\underline{4.0 \times 10^{4}\ A}}$

Question 2

Using circuit diagram below calculate:



(a) Total resistance

(b) Total current

(c) Current in each branch of the circuit

Solution

$R_{BC1} = R_2 + R_3$

$= 2 + 4$

$= \underline{6\Omega}$

$\dfrac{1}{R_{BC2}} = \dfrac{1}{6} + \dfrac{1}{6} = \dfrac{1+1}{6} = \dfrac{2}{6}$

$\Rightarrow R_{BC2} = \dfrac{6}{2} = 3$

$R_{BC2} = \underline{3\Omega}$

$\dfrac{1}{R_{DE}} = \dfrac{1}{R_9} + \dfrac{1}{R_{10}}$

$$= \frac{1}{20} + \frac{1}{10} = \frac{1+2}{20} = \frac{3}{20}$$

$$R_{DE} = \frac{20}{3} = \underline{\underline{6.7\Omega}}$$

$$R_{AC} = R_1 + R_{BC}$$
$$= 5 + 3$$
$$\underline{\underline{8\Omega}}$$

$$R_{AC2} = R_5 + R_6 + R_7$$

$$= 3 + 30 + 16$$
$$= \underline{49\Omega}$$

$$\frac{1}{R_{AC}} = \frac{1}{R_{ACI}} + \frac{1}{R_{AC2}}$$

$$= \frac{1}{8} + \frac{1}{49}$$

$$\frac{1}{R_{AC}} = \frac{49 + 8}{8 \times 49} = \frac{57}{392}$$

$$R_{AC} = \frac{392}{57} = 6.88$$

$$= \underline{6.9\Omega}$$

Total Resistance is R_T

$$R_T = R_{AC} + R_8 + R_{DE}$$

$$= 6.9 + 10 + 6.7$$

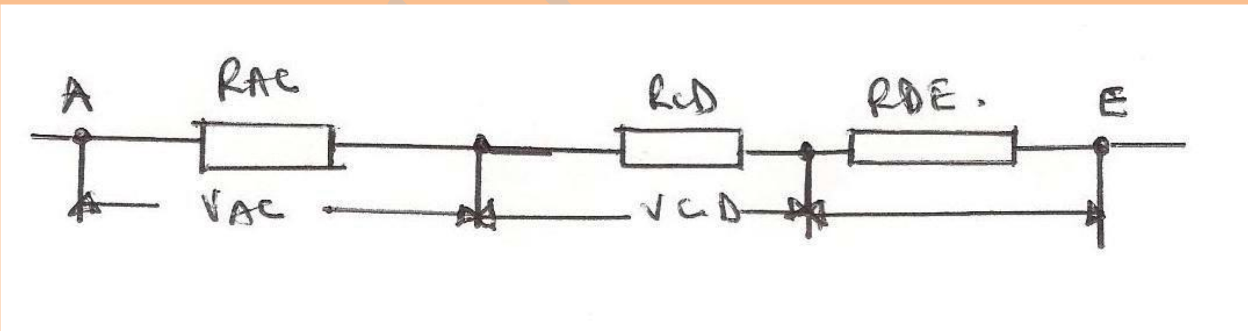
$$= \underline{\underline{23.6\Omega}}$$

b. Total current I_T

$$I_T = \frac{V}{R_T} = \frac{200}{23.6} = 8.47A$$

$$= \underline{8.47A}$$

c.



$V = V_{AC}$ $V_{AC} + V_{CD} + V_{DE} = 200V$

$R_{AC} = 6.9$, $R_{CD} = 10$, $R_{DE} = 6.7$

$V_{AC} = IR_{AC} = 8.47x6.9 = 58.50V$ -

$V_{CD} = IR_{CD} = 8.47x10 = 84.70V$

$V_{DE} = IR_{DE} = 8.476.7 = 56.82V$

(i) Current, I_1 (across R_5, R6, R7) $= \frac{VAC}{R_{AC2}} = \frac{58.50}{49} = 1.2A$

(ii) Current, I_2 (across R_1) = 8.47 – 1.2 = 7.27A

(iii) Current, 1_3 (across R_2, R_3, R_4) $= \frac{7.27}{2} = 3.64$A each

(iv) Current, I (across R_8) = 8.47A

(v) Current, I_4 (across R_9, R_{10}) = 5.64A & 2.82A respectively

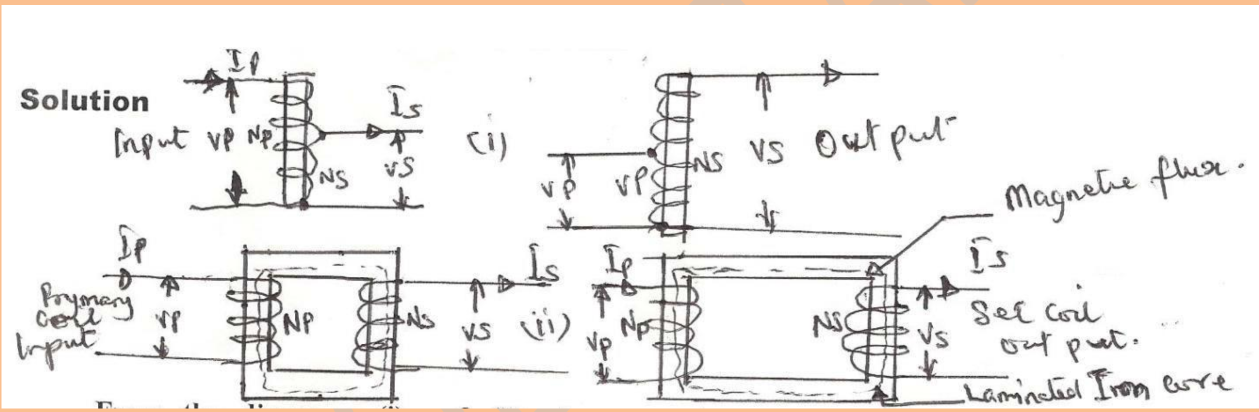
Question 3

(a) Describe briefly, with the aid of sketches how an auto transformer differs from a double-wound transformer.

(b) Give ONE advantage and ONE disadvantage of the auto-transformer compared with a double-wound transformer

(c) Calculate how many coulombs of electricity flow around a circuit when a current of 10A flows for 30 seconds.

Solution



From the diagrams (i) and (ii) of auto and the double wound transformers respectively we have that

1. The auto-transformer requires less materials to construct it windings than the double-wound transformer
2. The auto-transformer operates the principle of self inductance because of the single winding while the double wound transformer operates the principle of mutual inductance because of the two (double) windings.
3. In the auto-transformer, there is direct electrical connection between the primary and secondary coils but in the double there is no physical electrical connection between the primary and secondary coils.

4. In the double-wound transformer, there are two windings. The primary coil is connected to the source of supply while the load is connected across the secondary coil. In the auto-transformer, there is only one winding and it serves as both primary and secondary winding.
5. In the double-wound transformer, the primary winding indicates the value of voltage input and the secondary winding serves as the out put voltage but in the auto-transformer both the input and output are in one winding.

b. One advantage of auto-transformer over the double wound transformer is that the auto-transformer is less expensive (cheaper) than the double-wound transformer in terms of the needed materials for their construction.

One disadvantage of the auto-transformer over the double-wound transformer is that the auto-transformer is limited in its use because of the inherent danger in the direct connection which exist-between the input and out put terminals. This makes it difficult for heat losses to be minimized.

c. Q = It (coulombs of electricity)

I = 10 A

T = 30C

$\Rightarrow$ Q = It = 10 x 30

= <u>300C</u>

Question 4

(a) With the aid of a well labeled diagram, briefly explain the constructional and operational principle of a moving coil instrument.

(b) Briefly explain the following terms:

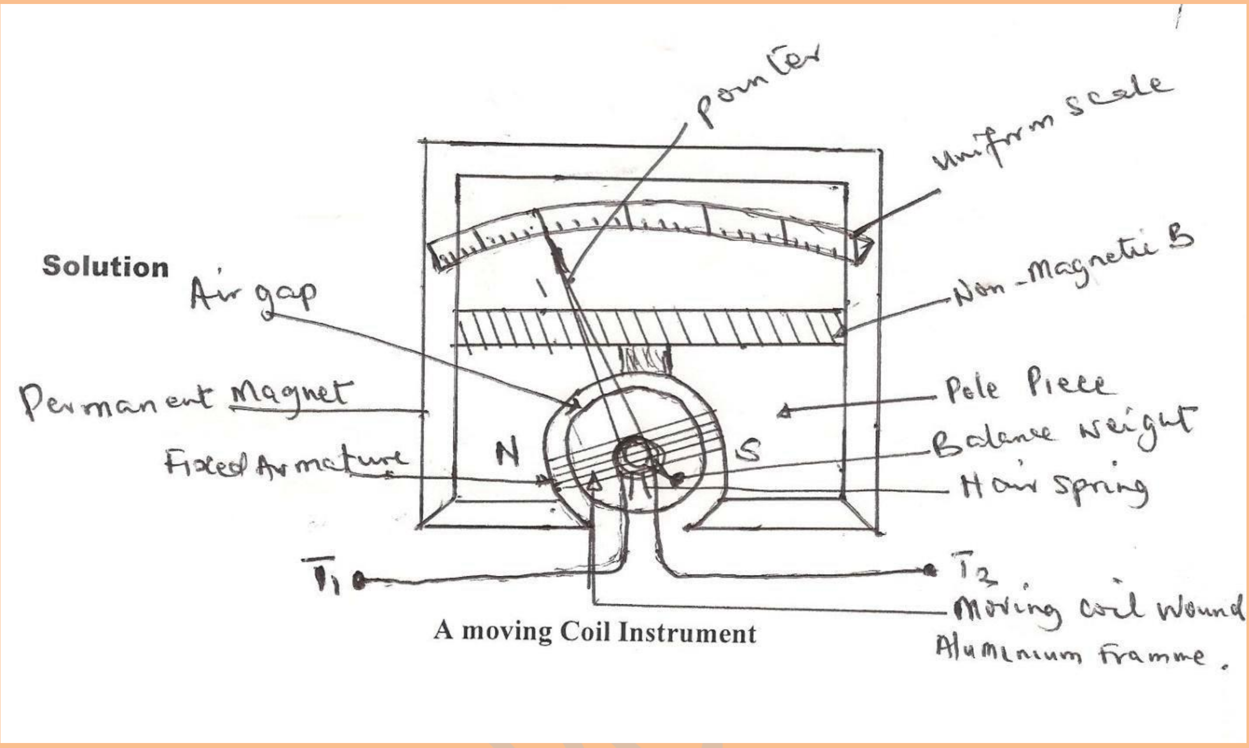
(i) Matter

(ii) Electronmotive force

(iii) Electron

(iv) Energy
(v) Proton

Solution



A moving Coil Instrument

Construction

The moving coil instrument consists of a number of turns of fine insulated copper wire wound on aluminous frame. The coil is supported by spindles, resting in jeweled bearing for easy rotation in the gaps between the soft iron poles pieces and fixed iron armature.

The magnetic field in the gaps is produced by a powerful permanent N-S magnet. The soft iron armature serves to concentrate the magnetic flux so as to obtain uniform magnetic field in the gaps.

Operation

The operation of the moving coil instrument is based on three factors

(i) How the operating torque is produced
(ii) How the control torque is produced and
(iii) How damping is achieved to prevent the pointer from oscillation

(i) The current to be measured is fed into and out of the moving coil through the two hair springs. This current causes an electromagnetic field which interacts with the field produced by the permanent magnet. This action causes the coil to rotate so that the hair springs either swings up or unwind to produce the torque that returns the coil to the zero position.

(ii) The action of the hair springs also provides the control torque for the pointer which indicates the value of the current on a uniform (even) divided scale. The weight of the pointer is counter balanced by two or more small weight of the pointer to cause the coil to rotate the by resulting in false reading.

(iii) During the rotation of the coil, eddy current is induced in the aluminium frame that produces a braking effect and also provides for the necessary dampling torque. As soon as the current stops flowing the field leases and the pointer returns to zero position on the scale.

b.

(i) Matter is anything that has weight (mass) and occupies space. Each matter consists of molecules, atoms, electrons and nucleus ie Matter – Molecules – Atoms – electrons + Nucleus

(ii) Electromotive force of a cell is the total energy generated per unit charge obtained from a cell. It is a measure of the potential difference across the terminals of the cell on open circuit. It can also be defined as the algebraic sum of the potential differences acting in a circuit or the force that drives current round the whole circuit ie though the internal and external resistors. The unit is volts (v) and symbol, E

(iii) Electron is the negatively charge elementary particle found in the outer most layer of the nucleus of an atom. It has same magnitude as the proton of an atom and very small mass. For a neutral atom, the number of electrons is the same as the numbers of the protons.

(iv) Energy is the ability to do work. Any body that can do work is said to have energy. The S.I unit of energy is Joules (J) Fundamentally, Energy is regarded as work done or force multiplied by the distance moved in the direction of the force.

(v) Proton is the positively charge elementary particle that forms the nucleus of an atom. It is about 1836 times heavier than electron. It is a stable charge of mass 1.67 x 10^{-27}kg, having charge, Q = 1

Question 5

(a) A purely capacitive circuit of 31.8μF is connected to a 240V $50H_Z$ supply. Calculate the capacitive reactance and the circuit current.

(b) List THREE types fluxes and FOUR advantages for using it is soldering work.

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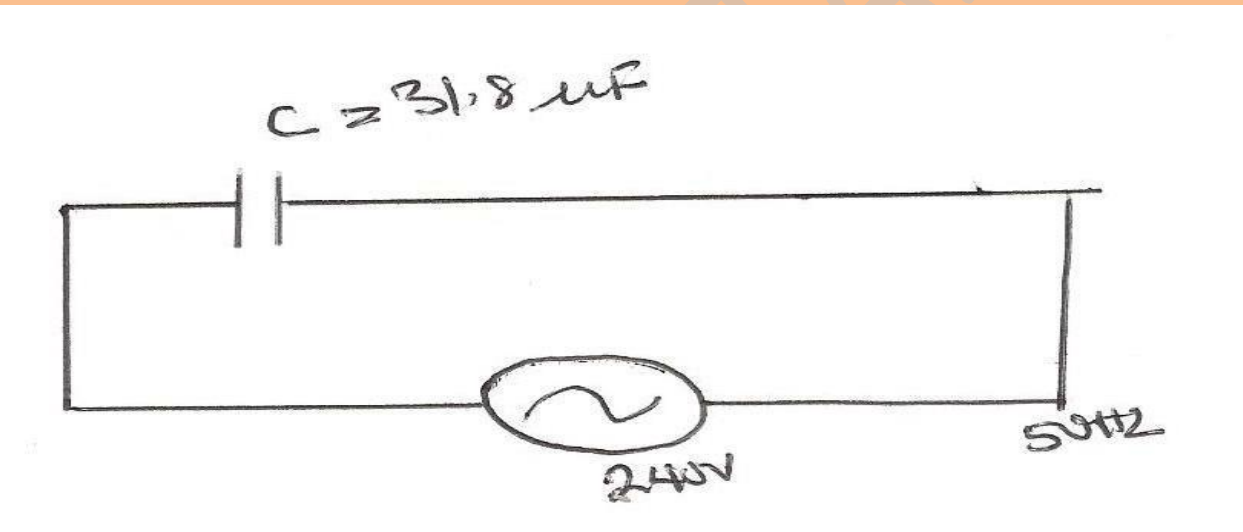

A(i) Capacitive Reactance, X_c

$$X_c = \frac{1}{Wf} = \frac{1}{2\pi fc}$$

$$= \frac{1}{2x3.142x50x31.8x10^{-6}}$$

$$= \frac{1 x10^6}{2x3.142x50x31.8x10^6}$$

10^6

9991.56

$= \underline{\underline{100.1\Omega}}$

(ii) Circuit current, I

$$I = \frac{V}{X_C} = \frac{240}{100.1}$$

$$= 2.39$$

$$= \underline{2.4A}$$

b. Three types of fluxes

(i) Pure amber Resin
(ii) Activated Resin and
(iii) Fluxite
(iv) Killed spirit

Four advantages for using fluxes in soldering works

i. It helps to remove oxide film from the surface of the conductor (presents oxidation)
ii. It helps to prevent the oxide film from re-formation (prevents corrosion)
iii. Helps to keep the joints wet
iv. Helps as cleaning agent
v. Helps for easy flow of solder over the joints (Any four)