



Important suggestions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance.
- 4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) Some of the questions are not clearly indicative of the exact answer expected. In such cases, credit may be given by judgment of relevant answer based on candidate's understanding.

Q.1 Attempt any Five of the following

a) Define resistance. State its unit. State effect of temperature on resistance.

Resistance:-----(1 Mark)

It is defined as the opposition offered by a conductor to the flow of current. It is represented by R

OR The formula for resistance is given by

$$R = \dots \times (l/a) \quad \text{OR} \quad R = V/I$$

Unit – ohm-----(1 Mark)

Effect of temperature on resistance- -----(2 Mark)

- In a material where the resistance increases with temperature it is said that the material has a positive temperature coefficient.
- When resistance falls with an increase in temperature the material is said to have a negative temperature coefficient.
- When there is no change in resistance value with increase or decrease temperature the material is said to have a zero temperature coefficient.

b) Describe active power and reactive power with the help of diagram. (Active power-2 Marks & Reactive Power-2 Marks)

Active Power (P):-

The active power is defined as the average power P_{avg} taken by or consumed by the given circuit.

OR

It is given by $P = V.I.Cos\phi$ watt **Unit :-** Watt **OR** Kwatt

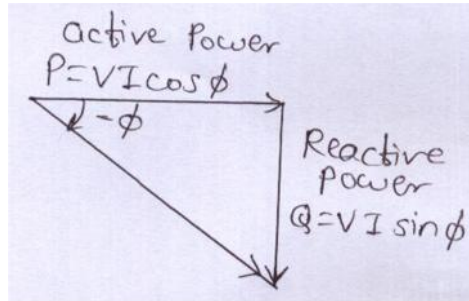


Winter- 2012 Examinations

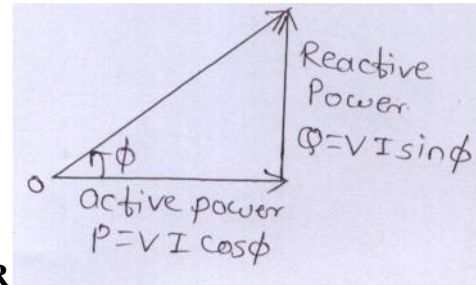
Subject Code: 12169

Model Answer

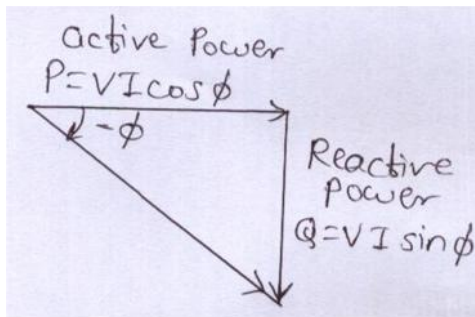
Page 2 of 18



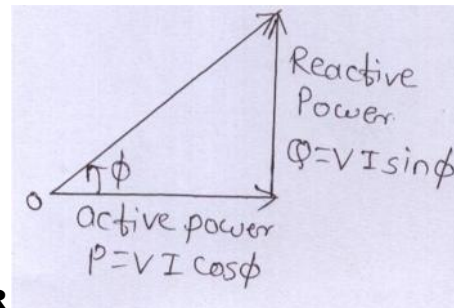
OR



ii) Reactive Power (Q):-



OR

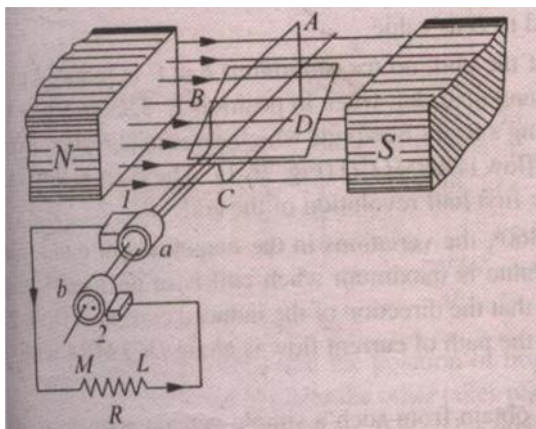


The reactive power is defined as the product of V, I and sine of angle between V and I
i.e. W

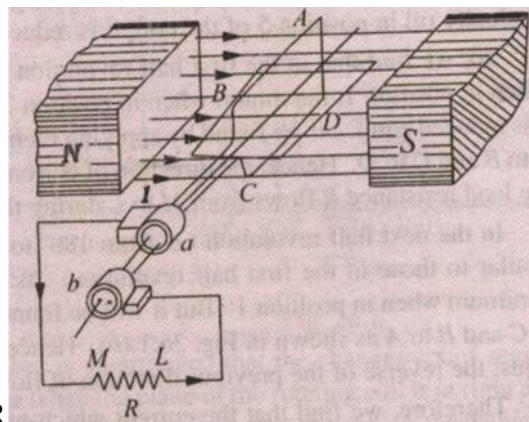
It is given by $Q = V.I. \sin W$

Units :- VAR OR KVAR

c) With the neat diagram explain DC generator principle. (Figure-2 Marks & Explanation-2 Marks)



OR



or equivalent dia.

Principle:-

Generator works on the principle of Faradays Laws of Electromagnetic induction:



Winter– 2012 Examinations

Subject Code: 12169

Model Answer

Page 3 of 18

First Law: - Whenever change in the magnetic flux linked with a coil or conductor, an emf is induced in it. **OR** Whenever a conductor cuts magnetic flux, an emf is induced in conductor.

Second Law: - The Magnitude of induced emf is directly proportional to (equal to) the rate of change of flux linkages.

$$e = \frac{-Ndt}{dt} d\phi$$

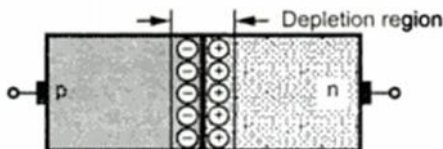
d) State the type of motor used for following application.----- (1 Mark each point)

- 1) **Blowers and fans-** D.C. shunt motor or constant speed motor or induction motor or synchronous motor.
- 2) **Cranes and hoist-** D.C. series motor or slip ring induction motor or D.C. compound motor.
- 3) **Electrical locomotive-** D.C. series motor or D.C compound motor or induction motor or single phase A.C series motor
- 4) **Lathe-** D.C. shunt motor or induction motor.

e) Draw constructional sketch of PN junction diode. State its two applications.

(Allotted 2 Mark for diagram, 1 Mark for each Application)

Constructional Sketch of PN junction diode. -



or equivalent dia.

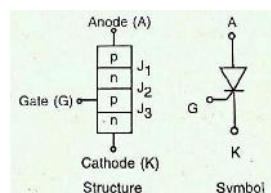
Applications of PN junction diode.

1. In rectifier circuit
2. In wave shaping circuit
3. In protection circuit

f) Draw constructional sketch of SCR. Explain its working. -

(Allotted 2 Mark for diagram, 2 Mark for Explanation /Working)

Symbol and structure of S.C.R.:-





Working-

When the anode is made +ve w.r.t. cathode, the junctions J1 and J3 are forward biased, whereas junction J2 is reverse biased. Due to this reverse biased junction J2, only small leakage current flows from anode to cathode. The S.C.R. is then said to be in forward blocking state.

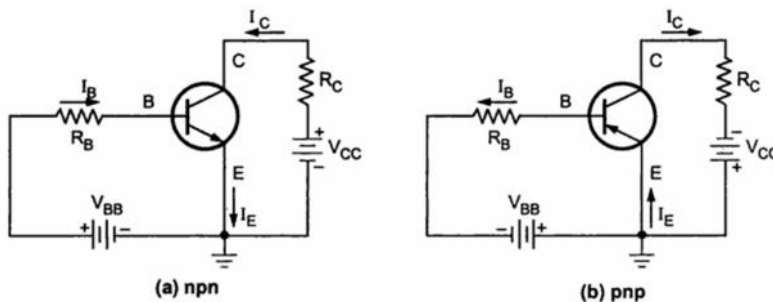
With anode +ve w.r.t. cathode, if anode-to-cathode voltage is increased to a sufficient large value, the reverse biased junction J2 will break. The voltage at which it occurs is called forward break over voltage V_{BO} . The junctions J1 and J3 are already forward biased, hence results in free movement of carriers across all three junctions, resulting in large forward anode current. The S.C.R. is said to be in conducting state.

Without breakdown of junction J2, S.C.R. can be made ON by applying +ve voltage to gate w.r.t. cathode. Due to this, junction J3 is forward biased and conducts and gate current flows. Free movement of carriers (holes and electrons) across the junction J3 results in injection of holes into n-region and electrons into p-region. The injected electrons in p-region force this p-region to lose its identity as p-region because it was having holes as majority carriers but with injected electrons, it is having holes as well as electrons in majority. Therefore junction J2 now has majority electrons on both side and it is disappeared and S.C.R. is made ON.

g) Draw and explain common emitter configuration of an amplifier.

(Allotted 2 Mark for diagram, 2 Mark for explanation)

Common emitter configuration of an amplifier:-



....Any one diagram (a or b).

Explanation:-

In common emitter configuration input is applied between base and emitter, and output is taken from collector and emitter. Here, emitter of the transistor is common to both, input and output circuits. Input resistance of this configuration is low while the output resistance is high. Its voltage gain is very high. This configuration is used for audio frequency applications.

Q.2 Attempt any two of the following

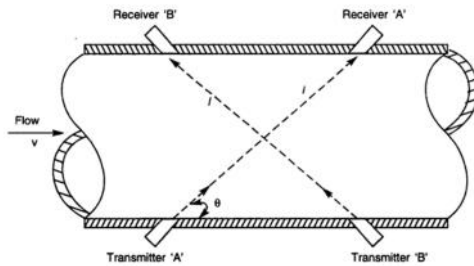
a) Explain operation of ultrasonic flow meter with suitable diagram. State its 2 advantages.

(Allotted 2 Marks for diagram, 4 Marks for Working Principle, 2 marks for advantages)



Ultrasonic flow meter Schematic diagram:-

There are two types based on – 1) Doppler effect , 2) Transit time.



or equivalent dia.

Working- Ultrasonic flow meter based on Doppler effect is explained here.

A and B are piezo-electric devices transmitting the short duration ultrasonic signals through the fluid that is flowing through the pipe at a velocity v . Similar type of crystals are used as receivers to respond to pressure fluctuations.

Due to the fluid velocity v aiding the transmission, the velocity of ultrasonic signal from the transmitter-A to receiver-A is increased to a value $c + v \cos \theta$, where c is the velocity of sound through the fluid in the pipe and θ is the angle between the path of sound and the pipe valve. The repetition frequency of the received pulse f_A will be

$$f_A = \frac{c + v \cos \theta}{l}$$

Where l = the distance between the transmitter and receiver. On the other hand, the velocity of the ultrasonic signal transmitted by transmitter B and received by receiver B will be reduced by the fluid velocity causing a retardation of $v \cos \theta$ and its pulse repetition frequency f_B will be

$$f_B = \frac{c - v \cos \theta}{l}$$

The difference between frequency is given by

$$\Delta f = f_A - f_B = \frac{2v \cos \theta}{l}$$

By measuring the difference in the repetition frequency Δf and knowing the values of c and l , the velocity of the fluid can be computed alternatively, the flow velocity can be computed by measuring the transit time difference between the two pulse trains in either direction.

Advantages-

1. Accurate measurements.
2. It involves no moving parts.



Winter- 2012 Examinations

Subject Code: 12169

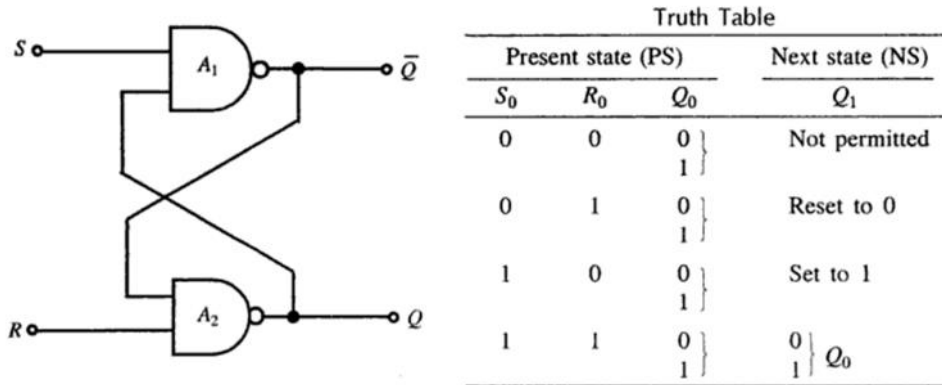
Model Answer

Page 6 of 18

b) Explain working of Rs flip flop using NAND gate.

(Allotted 2 Marks for diagram, 2 Marks for Truth Table, 4 marks for Working)

RS Flip-flop using NAND gate Circuit diagram and Truth Table:-



Working-

The basic SR flip flop has NAND gates connected back to back.

Case 1: S=0, R=0

When S=R=1, both Q and \bar{Q} may become 1. But this is not permitted, because we want Q and \bar{Q} to be complementary outputs.

Case 2: S=0, R=1 (Reset state) :-

When S=0, $\bar{Q} = 1$. Now R= $\bar{Q} = 1$, which makes the output 0.

Case 3: S=1, R=0

Whenever R=0, Q=1. Now both inputs to A₂ are 1, $\bar{Q} = 0$. This is called the set state.

Case 4: S=1, R=1

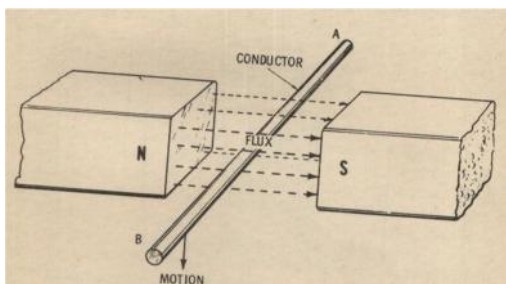
In this case both the inputs are equal to 1. A 1-input to NAND gate will not produce any change in the output. Hence output will remain in its previous state.

c) Describe production of induced E.M.F with diagram. State Faraday's laws of electromagnetic.

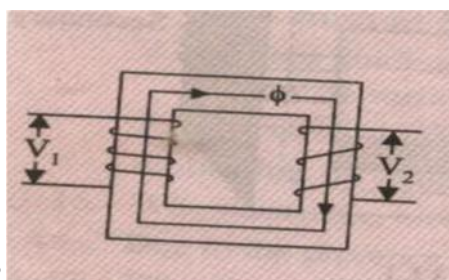
(Faradays Law-3 Marks & Figure- 1 Marks)

i) Dynamically induced EMF

ii) Mutually Induced EMF



OR



or equivalent dia.



Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 7 of 18

According to Faraday's law, emf is induced when a wire cuts (conductor) magnetic flux or by changing the flux links with conductor as shown in figure above.

Faraday's Laws of Electromagnetic:

First Law: - Whenever change in the magnetic flux linked with a coil or conductor, an emf is induced in it. **OR** Whenever a conductor cuts magnetic flux, an emf is induced in conductor.

Second Law: - The Magnitude of induced emf is directly proportional to (equal to) the rate of change of flux linkages.

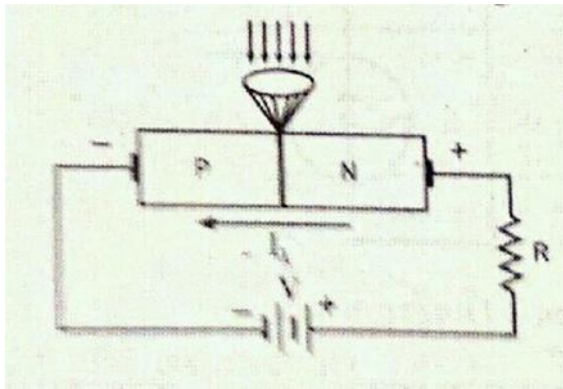
$$e = - \frac{Nd}{dt}$$

Q.3 Attempt any two of the following

a) Draw neat diagram and describe working principle photodiode and phototransistor.

i) Photodiode - (Allotted 2 Marks for diagram, 2 Marks for Working)

Schematic diagram



or equivalent dia.

Working-

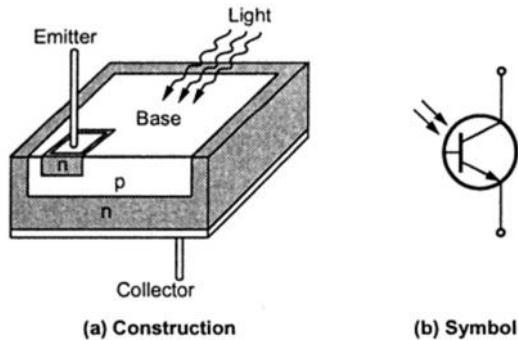
Photodiode is a two terminal semiconductor P-N junction device and is designed to operate with reverse bias. A photodiode is a p-n junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a free electron (and a positively charged electron *hole*).

When a reverse biased P-N junction is illuminated, the current flowing through it varies almost linearly with light flux. The output voltage is taken from across a series-connected load resistor R as shown in above figure.



ii) Phototransistor -(Allotted 2 Marks for diagram, 2 Marks for Working)

Schematic diagram



Working

The phototransistor has a light sensitive collector to base junction. A lens is used in a transistor package to expose base to an incident light. When the base is exposed to the light, the base current is produced which is proportional to the light intensity.

When no light is incident, a small leakage current flows from collector to emitter due to small thermal generation.

b) Draw any four electrical circuit symbols used in wiring. State meaning of wiring colour code.

(Electrical Symbol- 4 Marks & Wiring Colour code- 4 Marks)

Meaning of wiring colour code as follows- Student may write any one of below

i) For supply AC system --

1. For phase 1 wiring colour code is red.
2. For phase 2 wiring colour code is yellow.
3. For phase 3 wiring colour code is blue.
4. For neutral wiring colour code is black.
5. For Earthing wiring colour code is Green **OR**

ii) For supply dc system—

1. For positive wiring colour code is red.
2. For negative wiring colour code is blue.
3. For midwire wiring colour code is black.



Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 9 of 18

Symbols used in Wiring:- (Any four symbols from below or equivalent symbols accepted)

1. Direct current		14. Porcelain connector single way	
2. Positive		15. Neutral link	
3. Negative		16. Single pole switch	
4. Alternating current		17. Two-way switch	
5. Single phase	1ϕ OR $1\sim$	18. Push button switch	
6. Three phase	3ϕ OR $3\sim$	19. Intermediate switch	
7. Phase sequence	RYB	20. Lamp	
8. Neutral	\perp OR N OR O		
9. Crossed wires			
10. Connected wires			
11. Earth			
12. Fuse (rewirable)			
13. Cartridge fuse			
23. Fan			
24. Fan regulator		35. Double-pole, iron clad main switch with fuses	
25. Two-pin wall socket			
26. Three-pin wall socket		36. Triple-pole, iron clad main switch with fuses	
27. Two-plate ceiling rose			
28. Three-plate ceiling rose			
29. Electric bell			
30. Electric buzzer			

c) With suitable diagram explain working principle of stepper motor. State its type and its 2 application.

Types of Stepper Motor:-

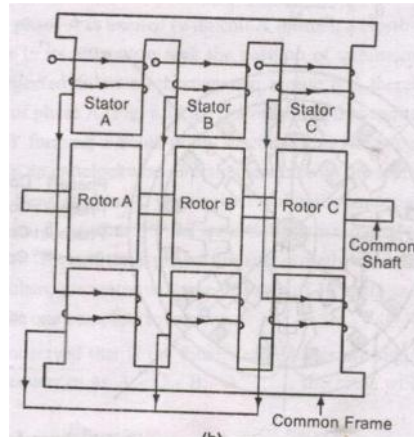
- 1) Variable Reluctance Motor
- 2) Permanent Magnet Motor

(Allotted 2 Mark)



1) Variable Reluctance Motors:-

(Allotted 2 Mark)



or equivalent dia.

Working:-

When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

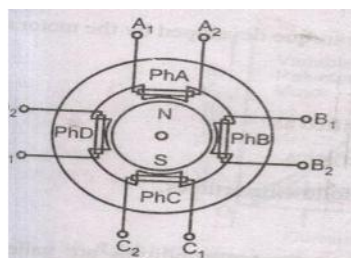
Then phase 'B' is excited disconnecting supply of phase 'A' then rotor will move 30 anticlockwise directions. The Same process is repeated for phase 'C'

In this way chain of signals can be passed to get one revolution and direction can be also changed.

OR

2) Permanent Magnet Motor :-

(Allotted 2 Mark)



or equivalent dia.

Working :-

If the phase is excited in ABCD, due to electromagnetic torque is developed by interaction between the magnetic field set up by exciting winding and permanent magnet.

Rotor will be driven in clockwise direction.

Applications-

(Allotted 2 Marks to any 2 applications)

1. In Floppy disc drives.
2. In Computer printers.
3. In image scanners.
4. In compact Disc drives, etc.



Q.4 Attempt any two of the following

a) Enlist different temperature transducers. Explain measurement of temperature using thermistor.

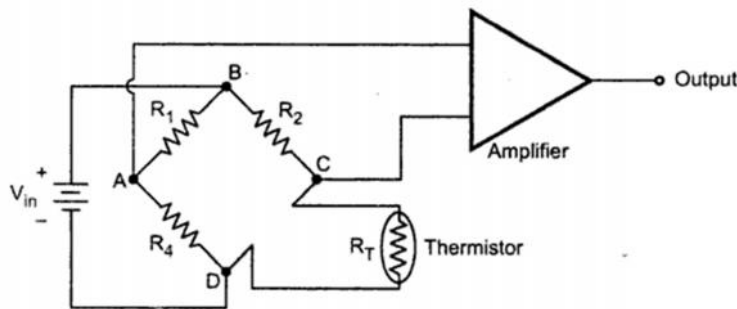
Different temperature transducers-

(Allotted 2 Marks)

1. Thermostat
2. Thermistor
3. Resistance Temperature Detector (RTD)
4. Thermocouple
5. Pyrometer

Measurement of temperature transducer using Thermistor

(Allotted 3 Marks)



Or any equivalent diagram.

Explanation :-

(Allotted 3 Marks)

The signal conditioning circuit for a thermistor includes a Wheatstone bridge and amplifier. The bridge is balanced under normal condition. If there is change in temperature, the resistance of thermistor changes due to high temperature sensitivity (Thermistor is normally NTC type and as temperature increases , resistance value of thermistor decreases). The bridge becomes unbalanced, producing small voltage across points A and C. This voltage is amplified using op-amp amplifier circuit and can be used to drive meter, relay or any other device.

b) Draw neat diagram of shift register and describe its working.

Shift Register:-

(Allotted 4 Marks diagram, 4 Marks to working)

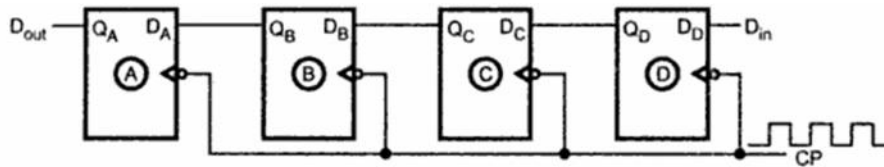


Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 12 of 18



Working

We will illustrate the entry of the four bit binary number 1111 into the register, beginning with the left-most bit.

Initially, register is cleared. So

$$Q_A Q_B Q_C Q_D = 0000$$

a) When data 1111 is applied serially, i.e. left-most 1 is applied as D_{in} ,

$$D_{in} = 1, Q_A Q_B Q_C Q_D = 0000$$

The arrival of the first falling clock edge sets the right-most flip-flop, and the stored word becomes,

$$Q_A Q_B Q_C Q_D = 0001$$

b) When the next negative clock edge hits, the Q_1 flip-flop sets and the register contents become,

$$Q_A Q_B Q_C Q_D = 0011$$

c) The third negative clock edge results in,

$$Q_A Q_B Q_C Q_D = 0111$$

d) The fourth falling clock edge gives,

$$Q_A Q_B Q_C Q_D = 1111$$

c) Write a short note on: i) Self inductance ii) Mutual inductance

i) Self inductance:-(4 Marks)

- This is property of the coil to oppose any change in current flowing through it is known as the self inductance.
- As per lenz's law the self induced e.m.f opposes any current change taking place.
- The symbol for self inductance is L.
- Expression for self inductance can be given as $L = (N \times f_l / I)$

Where N = number of turns.

$$f_l = \text{flux}$$

$$I = \text{current}$$



Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 13 of 18

ii) Mutual inductance----- (4 Marks)

- The fact that a change in the current of one coil affects the current and voltage in the second coil is quantified in the property called mutual inductance
- The mutual inductance can be defined as the proportionality between the e.m.f generated in coil 2 to the change in current in coil 1 which produced it.
- The symbol for mutual inductance is M.
- Coupling between the primary and secondary is most conveniently described in terms of mutual inductance.

$$M = \frac{e_m}{dI_1/dt} \quad \text{OR} \quad \text{Mutual Inductance } M = \frac{N_2 \Phi_{21}}{I_1} \quad \text{OR} \quad M = \frac{N_1 N_2 \mu_0 \mu_r a_1}{l}$$

Q.5 Attempt any two of the following

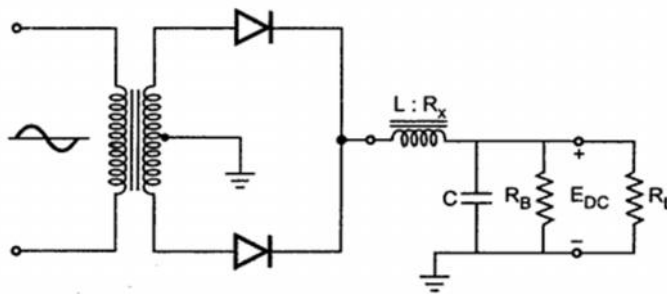
a) Define filter with its necessity. Draw centre tapped full wave rectifier along with LC filter circuit and waveform

Filter :-

(Allotted 2 Marks)

The output of rectifier circuit consists of a.c. ripples. The rectifier gives the output as d.c. + a.c. and not pure d.c (i.e. pulsating DC voltage). So as to get pure d.c. output, filter is necessary at the output side of rectifier.

Center tapped full wave rectifier along with LC filter circuit diagram (Allotted 4 Marks)

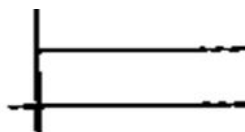


Waveforms-

(Allotted 2 Marks)

i) Input:-

ii) Output:-



(across primary)

(across R_L with filter)

(across R_L without filter)



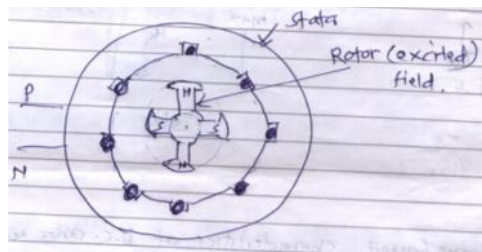
b) Explain with neat diagram principle working of Alternator.

(Allotted 4 Marks diagram, 4 Marks to explanation)

Working:-

(Allotted 4 Mark)

Working principal of Alternator is similar to D.C Generator. It also works on Faraday's Law of Electromagnetic Induction. Whenever excited rotor field is rotated by prime mover then as per Faraday's law of electromagnetic induction A.C Voltage will be induced in the Stator winding.



or equivalent dia.

(Allotted 4 Mark)

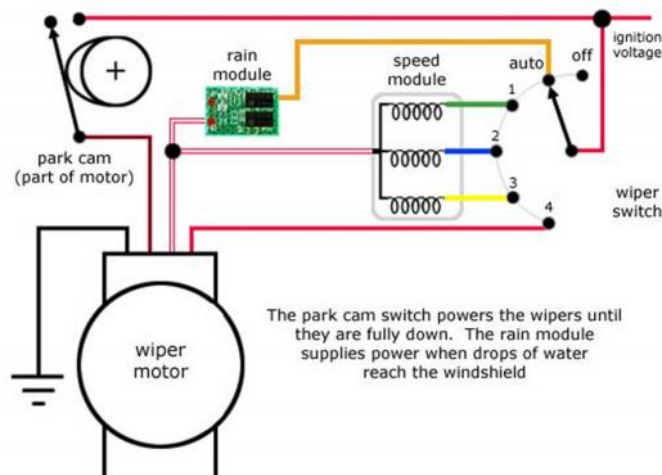
OR Student may write

- Alternator are operates on fundamental principles of electromagnetic induction.
- D.C Excitation is given to rotor, so it creates flux and rotor is rotated with the help of prime mover.
- Stator winding which is stationary cuts these flux so emf is induced in stator winding according to faradays law of electromagnetic induction.

c) Draw neat wiring diagram of windshield wiper and explain it.

(Allotted 4 Marks diagram, 4 Marks to explanation)

Windshield wiper circuit diagram:-



or any equivalent diagram



Explanation:-

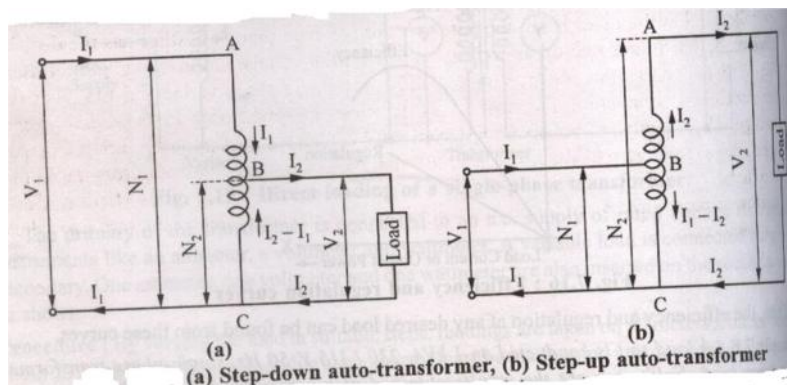
The ignition switch supplies electrical power for the wiper motor. Current passes through the wiper control switch and then to the wiper motor. A speed control module may vary the voltage that reaches the motor on some models. Other types use different windings in the motor to control speed.

Within the wiper-motor is another switch, with voltage that bypasses the off-switch. The motor times this device with the full down position. Many use a cam to open the circuit when the motor achieves wiper parking. Turn off the wiper switch and current continues to flow through the park-switch, until the wipers are fully down.

Q.6 Attempt any two of the following

a) Explain autotransformer with neat diagram. State its advantages and two applications.

(Explanation-2 Marks, Diagram-2 Marks, Advantages-2 Marks & Application- 2 Marks)



Autotransformer explanation:-

- It is a transformer with one winding only.
- Autotransformer is a special transformer in which a part of winding is common for the primary and secondary windings.
- It consists of only one winding wound on a laminated magnetic core, with a rotary movable contact.
- Autotransformer can operate as a step down or a step up transformer.

Advantages of autotransformer-(Any two accepted)

1. Saving of copper takes place.
2. Voltage regulation of autotransformer is better.
3. Autotransformer is smaller in size.



4. Cost is reduced in autotransformer as compared to conventional two winding transformer.
5. Losses are less in autotransformer.

Autotransformer Applications- (Any two accepted)

1. Autotransformer used as variac (to change the voltage).
2. Autotransformer can be used to start the ac machines such as induction motor .
3. Autotransformer is used to vary the supply voltage of a furnace .
4. Autotransformer can be used as a dimmerstat.
5. To give small boost to a distribution cable to correct the voltage drop.
6. Autotransformer used as interconnecting transformer in 132 kv/220 kv system.
7. Autotransformer used in control equipment for 1 phase and 3- phase electrical locomotives.

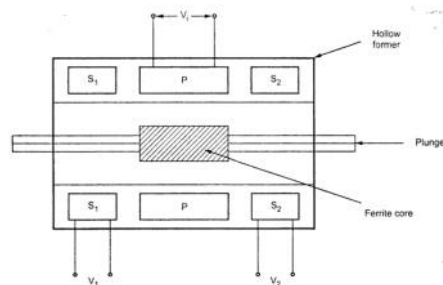
b) Describe operating principle of LVDT with suitable diagram.

(Allotted 4 Marks for diagram, 4 Marks for working)

Linear Variable Differential Transformer (LVDT):-

It is the transducer most widely used to translate linear motion into electrical signals.

Construction-



or equivalent dia.

P= primary winding

S1, S2= two secondary windings.

Working-

The secondary S1 and S2 are connected in series opposition so that voltages induced in each coil oppose each other. The electrical equivalent connection is shown below.

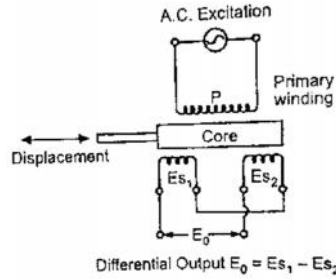
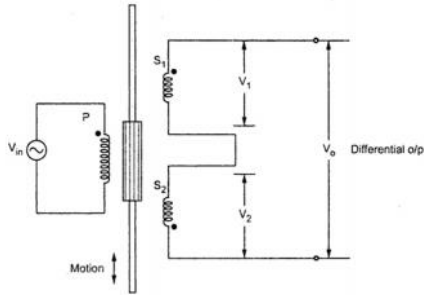


Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 17 of 18



OR

or equivalent dia.

The position of movable core determines the flux linkage between the primary and each of the secondary windings.

Let $V_1 =$ output of secondary S_1

$V_2 =$ output of secondary S_2

Then $V_0 = V_1 - V_2$

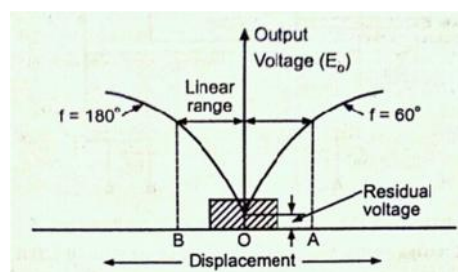
Case 1: when the core is at centre.

With the core in the centre, the induced voltages V_1 and V_2 in the secondary S_1 and S_2 are equal, since they oppose each other; the output will be zero volts.

Case 2: when core is displaced.

When the core is displaced from the null position, the induced voltage in the secondary towards which the core has moved increases while that in other secondary decreases.

The phase difference between the output and input voltage changes by 180 degrees when the core moves through the null position. Therefore in actual measurement to determine positions uniquely, this phase change over is measured with phase sensitive detector.



or equivalent dia.

c) Explain operation of load cell with diagram. State its 2 application

Strain Gauge load Cell:-

Construction:-

(Allotted 3 Marks)

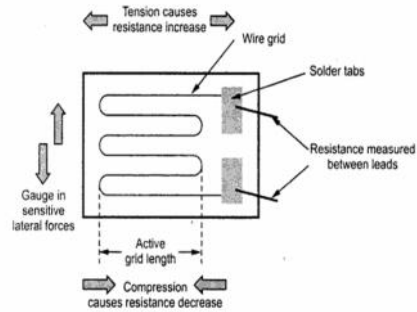


Winter- 2012 Examinations

Subject Code: 12169

Model Answer

Page 18 of 18



or equivalent dia.

Working-

(Allotted 3 Marks)

This consists of a fine wire element looped back and forth on a mounting plate (base). A tensile stress tends to elongate the wire and thereby increase its length and decrease its cross-sectional area. The combined effect is an increase in resistance. The strain of the wire grid is measured with the Wheatstone bridge connecting the gauge in one of the four arms.

Applications-

(Allotted 2 Marks)

1. Measurement of force
2. Measurement of pressure

END