DEV BHOOMI INSTITUTE OF TECHNOLOGY

CHAKRATA ROAD, NAVGAOUN
MANDUWALA, UTTARAKHAND

Programs: B.TECH. (Electrical and Electronics Engineering)

ELECTRIC DRIVE LAB
Laboratory Manual

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LIST OF EXPERIMENTS

ELECTRIC DRIVE LAB

1. To study speed control of single phase induction motor using micro controller.
2. Speed control of three phase slipring motor using static rotor resistance control through rectifier & chopper mosfet.
3. To perform speed control of separately excited dc motor using chopper.
4. Speed control of dc motor using closed loop and open loop.
5. To perform Micro controller based speed control of 3 phase induction motor by stator voltage control.

Experiment No-1
Theory and Concept

AIM :To study speed control of single phase induction motor using micro controller

EXPETINENTAL SETUP

It consisting of

1.Micro Controller Kit with firing circuit

2 Single Phase Induction Motor Capacitor Start (Fan type)

3 Patch Cord

4 Instruction Manual

THEORY: When single phase supply is applied across one single phase winding on winding the stator of a single phase induction motor, the nature of the field produced is alternating and such the rotor will not develop any starting torque. It has however been observed that once the motor is given an initial rotation a continues to rotate

In a single-phase motor, to provide starting torque, an additional winding is provided, which is called the auxiliary winding. The main and the auxailiary windings are connected in parallel across a single-phase supply. The impedence of the two windings are made deferent so that currents flowing through these windings will have a time phase difference as shown in Fig-'A"

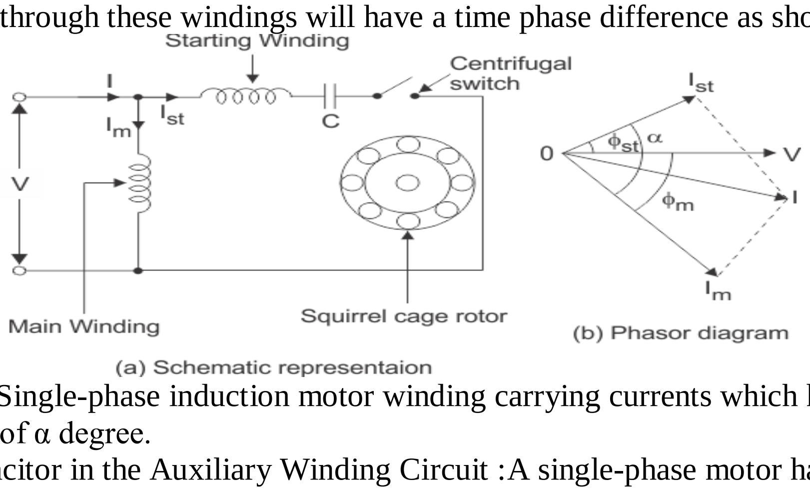


Fig-A Single-phase induction motor winding carrying currents which have a time-phase difference of α degree.

1 Need of a Capacitor in the Auxiliary Winding Circuit :A single-phase motor having a main winding and an auxiliary winding fed from a single phase supply can be considered as equivalent to a two-phase motor having a single phase supply.Since the two windings are not identical, the two currents Ist and Im, will have a time-phase displacement. Now if by any means the time-phase displacement between the two currents, In and 1,flowing through the two windings can be made 90', a single phase motor will behave exactly like a two phase motor. The

time phase displacement between lst, and Ia, can be increased by using a capacitor in the auxiliary windings as shown in Fig-B. The capacitor will also improve the overall power factor of the motor. From the phasor diagrams of Figs A and B . it will be observed that the power factor of the motor is improved when a capacitor is introduced in the auxiliary winding circuit. If a capacitor is to be used only for achieving high starting the auxiliary winding can be switched off when the motor picks up .

Time-phase difference of nearly 90 between the main and auxiliary winding Current Is achieved by using a capacitor in the auxiliary winding circuit SINGLE PHASE INDUCTION MOTOR

If motor is supplied through voltage controller a there by changing the firing angles of SCRs the voltage supplied to the motor can be changed and hence the speed of single phase induction motor is changed

Micro controller is used to generate the desired firing pulses. Default setting of micro controller is at 160° and angle can be varied between 0-160° by Increase (INC) and Decrease (DEC) switches .Default (DEF) setting of 160° is used to get minimum voltage at the time of switching the controller. MICRO CONTROLLER PCR-100 (80SI) is microcontroller based SCR Bridge controller.

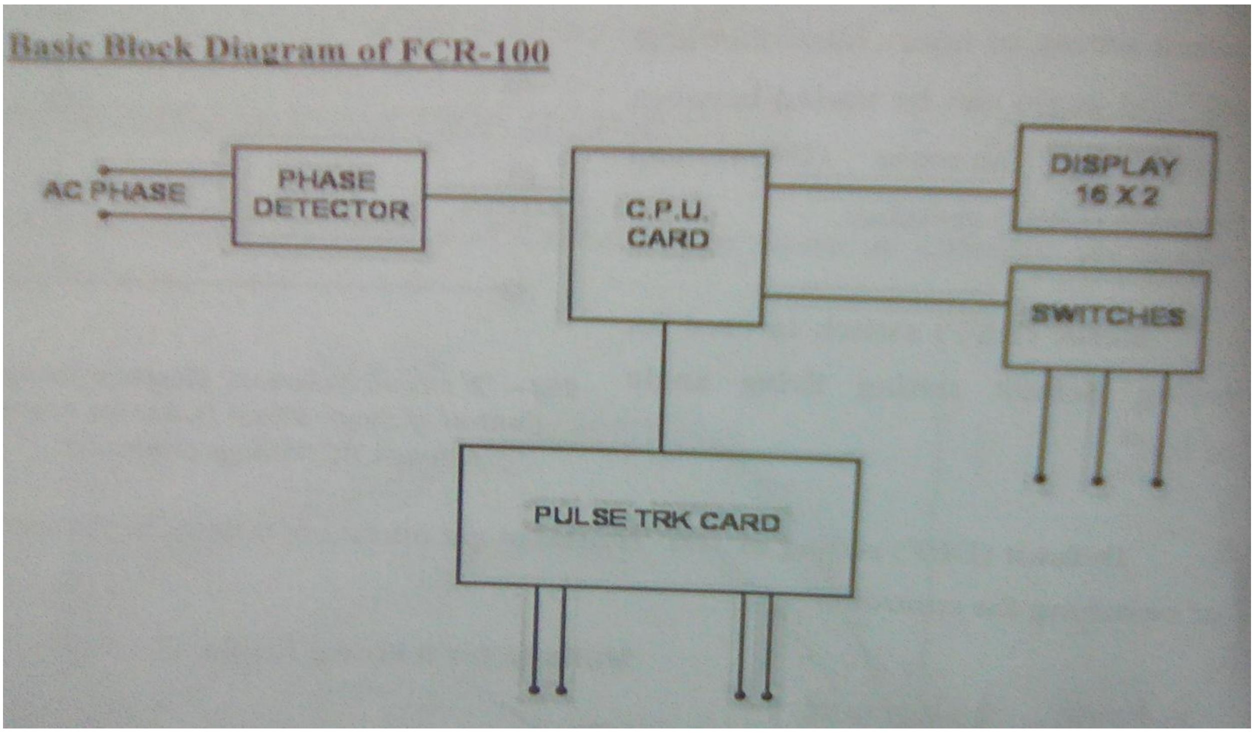
Following applications can be easily accomplished through FCR-100

> Full wave controlled rectifier

> Half wave controlled rectifier

> Single phase AC Motor speed controller

BLOCK DIAGRAM OF FCR 100



RESULT: If motor is supplied through voltage controller a there by changing the firing angles of SCRs the voltage supplied to the motor can be changed and hence the speed of single phase induction motor is changed

Experiment No-2
Theory and Concept

AIM :Speed control of three phase slipring motor using static rotor resistance control through rectifier & chopper mosfet

THEORY

The speed control is provided by providing resistance in the rotor circuit. The maximum torque does not depend upon value of rotor resistance. The rotor resistance influences slip at which maximum torque occurs .

The rotor speed of a 3-phase slip ring motor can be controlling the power controlled by the following method.

(a) By inserting adjustment external resistance in the motor.

(b) By varying stator voltage

(c) By injecting a voltage of slip frequency in the rotor circuit.

(d) By the recovery of slip power

Speed control of an Induction motor by an adjustable resistance in the rotor in fairly similar to that of a DC shunt motor by a resistance in the armature circuit.

The operation is stable only on the position of the torque speed curve. Where the speed drops as the torque increases. This method of speed control is useful where a large starting torque is required. The main disadvantage of this method is that the efficiency is low due to large ohmic loss in the rotor resistance. The speed control range is below the synchronous speed

It is suitable for intermitent load and cases where rapid acceleration or d required such as in cranes, hoists ec.. The external resistance can be varied by using tapped resistance and rotary switches But the speed control is not continuous and slow response. Smooth contact less control can be achieved by using phase controlled rectifier and a chopper in the rotor to control efficiency in the rotor circuit .

The phase controlled rectifier is not very suitable because the firing circuit to be synchronized in the rotor frequency which is variable and the magnitude of the rotor voltage varies considerably with the variation of speed, being lowest at synchronous speed and highest at stand still.

The chopper controlled resistance scheme is more advantageous because it does not frequency The resistance connected across the output with the rotor require terminals of a chopper can be varied from 0 to R by varying the duty cycle. When the chopper is OFF, the supply is always connected to the resistance R. Similarly when th chopper is ON the resistance is short circuited .

Hence by varying the time ratio from 0 to I the value of resistance can be varied from R to the slip power of the rotor is rectified by a diode rectifier and is fed to the chopper controlled The rotor current is sinusoidal The harmonics of the rotor e

This unit consists 2 parts

(a) Power circuit:This part consists of a 3-phase bridge rectifier to convert 3phase tor supply to DC supply An inductor is connected in series with the DC supply for

An Mosfet is provided for chopper control Mosfet is mounted on a proper heat sink.

(b) Control circuit The control circuit generates driver output for driving the Mosfet bro node. The duty cycle can be varied from 0% to 90%. The frequency can be also in chopper be varied Soft start and soft stop is provided for driver outputs.

FRONT PANEL DETAILS

POWER CIRCUITS

(i) Rotor

(ii) 3-Ph Rectifier - Terminals to be connected to the rotor points of slipring induction motor 16A/600V Diode Bridge Rectifier to converter rotor AC voltage to DC output. Positive & Negative points of rectified DC output Inductance to smoothen the rectifier DC

(iii) +&-

(iv) L

2 CONTROL CIRCUITS- 1Mains Power ON/OFF switch to the unit with built in indicator, Frequency,Duty Cycle,ON/OFF ON/OFF switch for the driver output with sat Potentiometer to vary the frequency Potentiometer to vary the duty cycle from 0% to 90% start/stop ,+ to Gate - to Emitter.

DETAILS OF CHOPPER CIRCUIT USING MOSFET

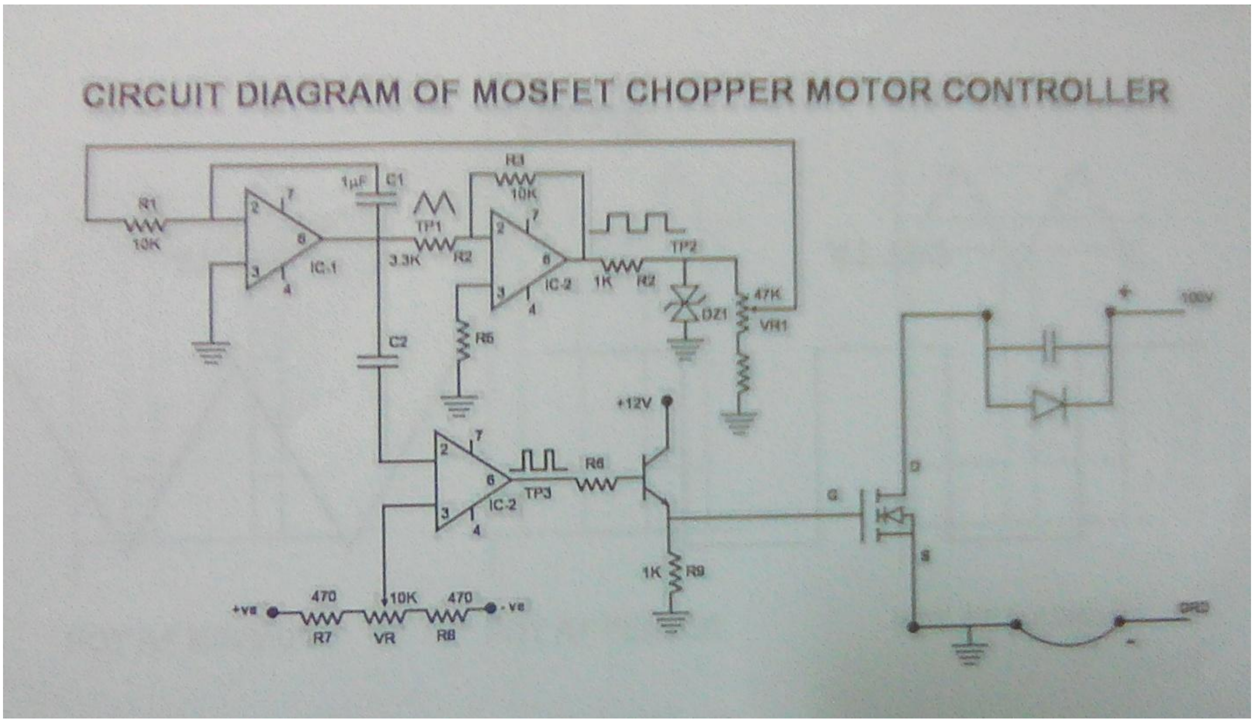
INTRODUCTION

There are several ways to the speed control of the DC Motor using DC source. The chopper based DC motor speed control is one of them. In this method we makes ON and OFF the DC supply to the motor with frequency as required. If the higher speed of motor the ON portion of wave will increase accordingly. At full speed the ON portion is 100% and at zero speed the OFF portion is 100%. required .

THEORY Consider the circuit diagram as given in Fig-1 Here an triangular pulse generator is used by IC-1, IC-2 and associate components RI, R2, R3, R4, R5, VRI, Cl, etc. IC-1 is and integrator and IC-2 is a comparator. The output of comparator is fed to the input of integrator through resistance RS, VRI and RI. The output of integrator is fed to the comparator resistance R2. In this way by making the feedback an oscillation forms, a triangular and square waves generates at TPI and TP2 .

The triangular wave is our requirement and fed to another comparator using IC-3 through capacitor C2. The reference voltage is variable i.e. -12V to +12V. As the triangular wave voltage increases the reference voltage, the output appears at pin No 6 and as the wave voltage decreases the reference voltage, the output at pin No 6 disappears.

If the total triangular wave is more than the reference voltage, the output voltage at pin No 6 become continues. If the total triangular wave is less than the reference voltage the output at pin No 6 will permanently disappear the output of pin No 6 is fed to and amplifier using transistor TI and the output of Tl is fed to the gate of IGBT which is in series of the load and DC supply.



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	Dev Bhoomi Institute Of Technology Department of electrical and electronics & Engineering		LABORATORY MANUAL
	PRACTICAL INSTRUCTION SHEET		
	EXPERIMENT NO. 3	ISSUE NO. :	ISSUE DATE:
	REV. NO. :	REV. DATE :	PAGE: 8
LABORATORY Name & Code: **PEE-752 electric drive lab Lab**			SEMESTER: VII

Experiment No-3

Theory and Concept

AIM : To perform speed control of separately excited DC Motor using Chopper

MACHINE REQUIRED

Experimental setup consists of separately excited DC Motor. Control panel consist of arrangement for controlling the voltage independently in the armature and field resistance using chopper

DC machine: The back emf for a DC motor is given by

$$E_g = \frac{\phi Z N}{60} X \frac{P}{A} \, volt$$

The number of poles P, the armature conductors Z and the number of parallel path A are constant for a particular machine Thus the speed of DC motor is given by

$$Thus, \ speed \ of \ rotation \ N \ = \ \frac{60A}{PZ} X \frac{E}{\phi}$$

$$\Rightarrow N = \frac{E}{k\phi} \ Where \ k = \frac{PZ}{60A} \ is \ a \ constant$$

N=K(V-IaRa)/ Φ .The equation for the speed of the motor clearly indicates the following

1.Speed of the DC motor can be controlled below the normal range of by varying the resistance in the armature circuit included in the form of a as a variable resistance (armature control)

2. Speed of the DC motor can be controlled above the normal range of by decreasing the flux such that by decreasing the current in the field circuit by including an external resistance in the form of variable resistance (field control).

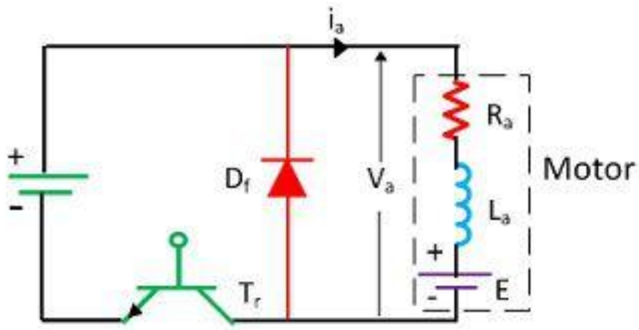
Armature Control,

Let the external resistance in the armature circuit of DC shunt motor be R ohm Then the speed equation modifies to N=K(V-Ia Ra)/ Φ .

Hence the speed of the motor decreases with an increase in the value of external resistance R. Thus reduced speeds lower than the no load speed can be obtained by this However; there is an excessive wastage of power in the additional resistance which lowers the efficiency of the motor considerably.

Alternatively speed of separately excited DC Motor can be controlled below no load has speed by providing chopper switch in the armature circuit. Since there are negligible losses in the chopper switch, the efficiency of the DC Motor increases considerably in comparison with conventional method of inserting additional resistance in the armature circuit.

Field Control: The speed of the DC motor can be increased beyond the no load speed by inserting an external resistance in the shunt field circuit. The current in the external resistance is very low, hence the losses occurring in the additional resistance is quite small Alternatively speed of separately excited DC Motor can be controlled above no load base speed by providing chopper switch in the field circuit Since there are negligible losses in the chopper switch, the efficiency of the DC Motor increases in comparison with conventional method of inserting additional resistance in the field circuit.



Chopper Control of Seprately Excited Motor

Circuit Globe

OBSERVATION TABLE

Sr no	Armature voltage (volts)	Speed (RPM)

Sr no	Field voltage (volts)	Speed (RPM)

Experiment No-4

Theory and Concept

AIM: Speed control of dc motor using closed loop and open loop.

Demonstration Board with following facilities

(a) Variable Armature DC Voltage (0-220 V) Closed Loop
(b) Variable Armature DC Voltage (0-220 V) Open Loop.
(c) Field Voltage
(d) Field Failure Protection
(e) Load Amp Meter
(f) RPM Meter
(g) Current Limit
(h) 3A Fuse for short circuit protection.
2. DC Motor with Tachometer

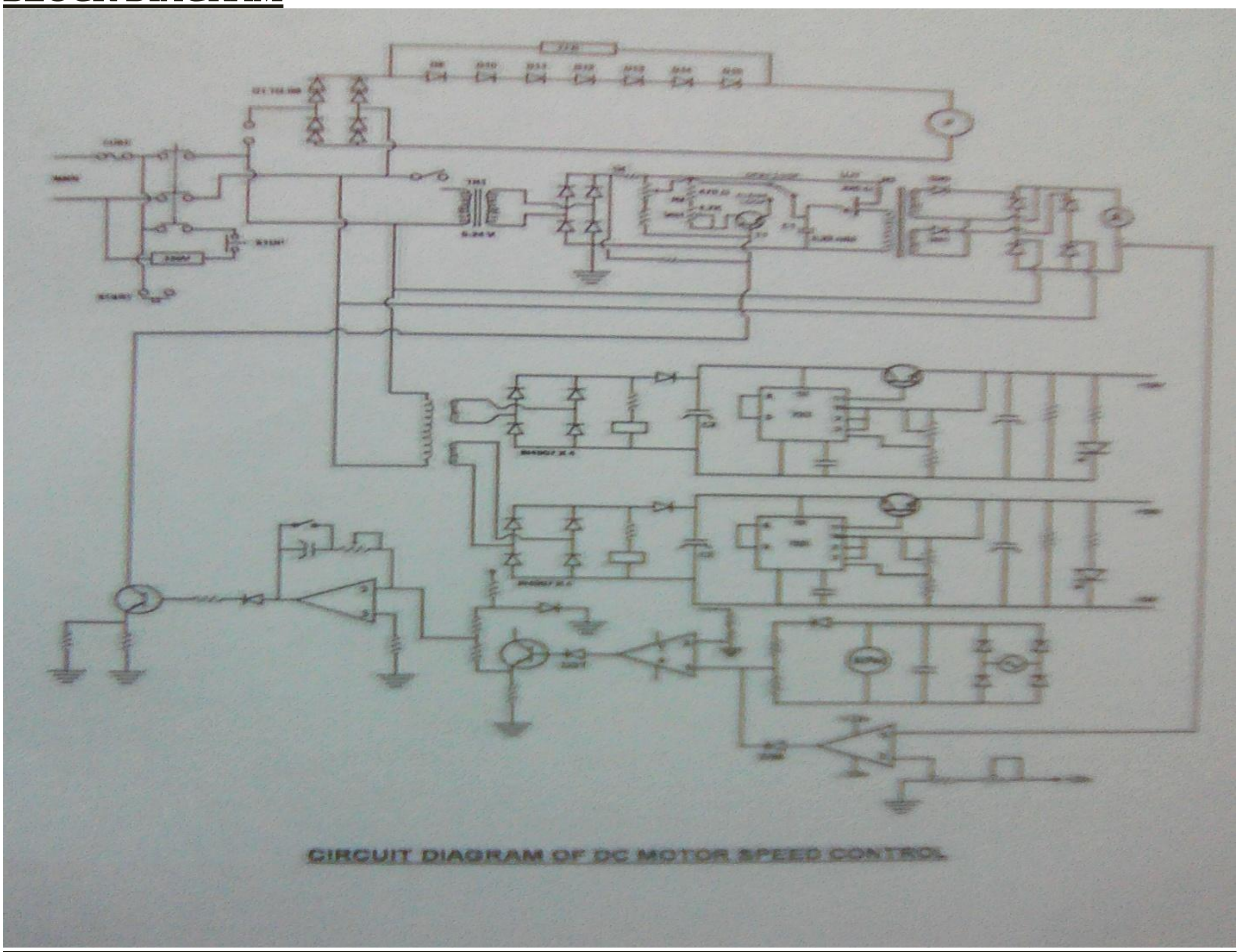
INTRODUCTION

DC motor speed control in several industries like thread manufacturing, Offset Machine, Cutting Machines etc. In heavy industries machine soft starting is essential so that is achieve also by motor speed control or ramp starting like crane operation to avoid hammering to object/machine. DC Motor speed control can achieve by using V Rheostat and by Power Electronics Device SCR. The oldest method was by using rheostat Then Variac and now SCR is used. Here we are discussing the detail controlling of DC Motor by SCR.

START-STOP: The 230V AC fed to fuse &then Con-1. By pushing start button, the contactor operate & locked by its aux contact. Now this AC supply fed to the following section

Field supply: 230 AC supply fed to the field section diode DI to D8 some for rectification, D9 to DI5 for dropping purpose to operate relay F.F.R.& the fed to field port. 230 AC supply fed to transformer T2 & it have 18 & 18 V Isolated voltage 18 V AC is for 112 V & other for 12V supply developing. One of these 18 V AC is fed to diode D24 to D27 for rectification. Relay RLl for shaft starting in close loop mode C2 for filtration Diode D28 is to present relay de-energies. The RL1, 14 & T2, R6, VR3, C4, R7 is for regulation. VR3 is to vary the O/P voltage 12V the circuit diagram of -12V is same as 230 V AC is also fed to half controlled bridge. It has SCRI, SCR2 diode D22 & D23 for rectification. Diode D40 is freewheeling diode. The firing pulse for SCR comes through diode D20 & d21. The DC output is fed to ammeter point through shunt resistance (current control 230V is also fed to the transformer TRI For output of TRI is 24 V AC D16 to DI9 is for rectification. Resistance R20 & zener D2 is to make the wave shape trapezoidal Resistance R1 & VRI is a potential divider The O/P of VRI is feed to capacitor CI through switch SW1. The charging of capacitor is controlled by VRI As the capacitor changes up to threshold voltage of UJT The UJT fire & a current flows through the pulse transformer primary & in its secondary the pulses transformer A tachogenerator is placed in with the shaft of motor &generator The voltage according with speeds. The generator AC is rectified by Diode D33 to D36. Capacitor CS is for filtration. RPM meter is to read the motor RPM. Diode D41 is to block the DC voltage from capacitor circuits.

BLOCK DIAGRAM



OBSERVATION TABLE

Sr no	Load amp	Speed (RPM)

PRECAUTION

1 the motor should not be more than 1 HP.

2 the lamp load should not be more than 25 watt.

Experiment No-5
Theory and Concept

AIM :To perform Micro controller based speed control of 3 phase induction motor by stator voltage control.

DESCRIPTION

The unit consist of two parts

1 POWER CIRCUIT By changing the firing angle of the thyristor the rms value of the stator voltage can be regulated.

2 CONTROL CIRCUIT FCR 100(8051) microcontroller based SCR bridge controller is used for controlling the firing circuit.

THEORY :Since induction motor in light load condition is combination of resistance and inductance is dominating have the effective control stars from firing angle of 80^{o} and goes up to 145^{o}. When firing angle increasable beyond 145^{o} the voltage becomes too less and motor stops. A three phase induction motor is basically a constant speed motor so it's somewhat difficult to control its speed. The speed control of induction motor is done at the cost of decrease in efficiency and low electrical power factor. Before discussing the methods to control the speed of three phase induction motor one should know the basic formulas of speed and torque of three phase induction motor as the methods of speed control depends upon these formulas.

Synchronous Speed

$N_s = \frac{120f}{P}$ Where, f = frequency and P is the number of poles

The speed of induction motor is given by,

$N = N_s(1-s)$ Where,

N is the speed of rotor of induction motor,

N_s is the synchronous speed, S is the slip. The torque produced by three phase induction motor is given by, $T = \frac{3}{2\pi N_s} X \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$ When rotor is at sandstill slip, s is one.

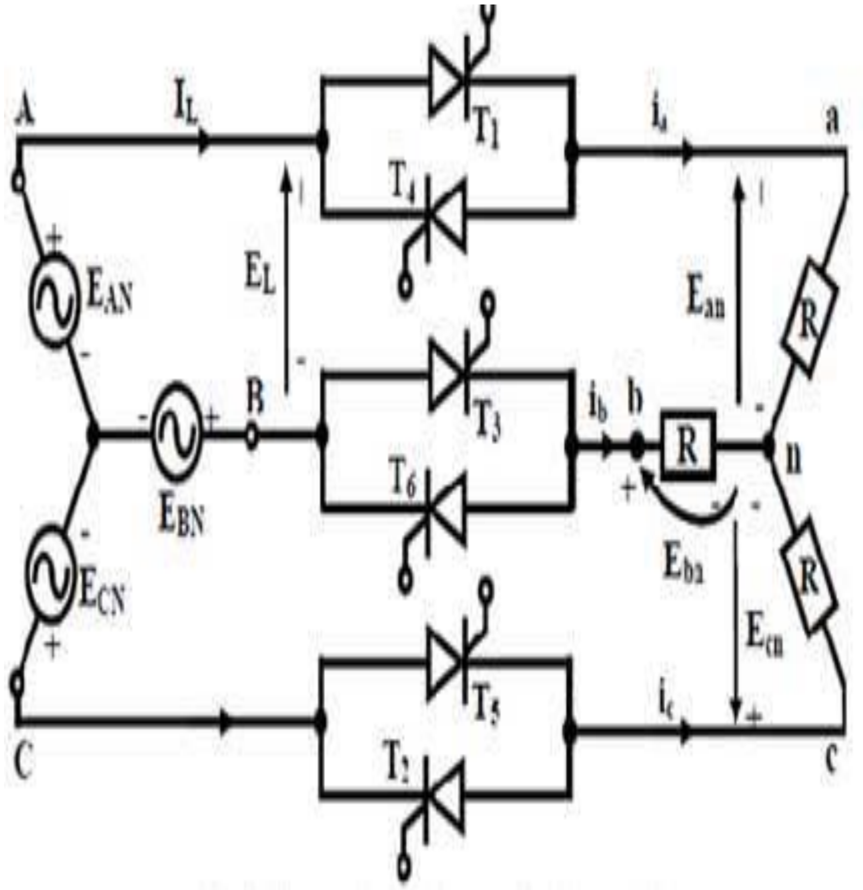
So the equation of torque is, $T = \frac{3}{2\pi N_s} X \frac{E_2^2 R_2}{R_2^2 + X_2^2}$ Where,

E_2 is the rotor emf
N_s is the synchronous speed
R_2 is the rotor resistance
X_2 is the rotor inductive reactance.

Controlling supply voltage: The torque produced by running three phase induction motor is given by $T \propto \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2}$ In low slip region $(sX)^2$ is very very small as compared to R_2. So, it can be neglected. So torque becomes $T \propto \frac{sE_2^2}{R_2}$ Since rotor resistance, R_2 is constant so the equation of torque further reduces to $T \propto sE_2^2$ We know that rotor induced emf $E_2 \propto V$. So, $T \propto sV^2$.

From the equation above it is clear that if we decrease supply voltage torque will also decrease. But for supplying the same load, the torque must remains the same and it is only possible if we increase the slip and if the slip increases the motor will run at reduced speed. This method of speed control is rarely used because small change in speed requires large reduction in voltage, and hence the current drawn by motor increases, which cause over heating of induction motor.

DIAGRAM :AC voltage controller feeding three phase induction motor.



OBSERVATION TABLE

Sr no	Firing angle	Speed (RPM)