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Field Oriented Control Technique for Speed Controlling of Induction Motor

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Abstract : Speed control is the day to day need of most domestic as well as industrial devices. Variation of speed & torque, gives desired results . Various speed control technique namely scalar control, direct vector control, foc etc. are used for speed variation. In this paper more focus is given on FOC *i.e.* field oriented control. Assessment between reference & actual quantities like torque & speed is made and various estimation has been done. This paper show how induction motor will vary its speed & torque to meet the required result. Also study of different types of variation in speed and torque waveform is shown in this paper.

Keywords : vector-control, speed control, torque control, induction motor, speed regulator, IGBT Inverter

1. INTRODUCTION

In 1970's, the method of vector control/FOC research took place. It is invented by Blaschke (1971-1973). The possibility of induction motor acting like a independently energized dc motor is assembled & radical change has been brought in ac electrical drives. Due to dc machine like operation vector direct is also called by name decoupling, orthogonal or transvector control. The principle of vector rule can be applied together on induction & synchronous motor.

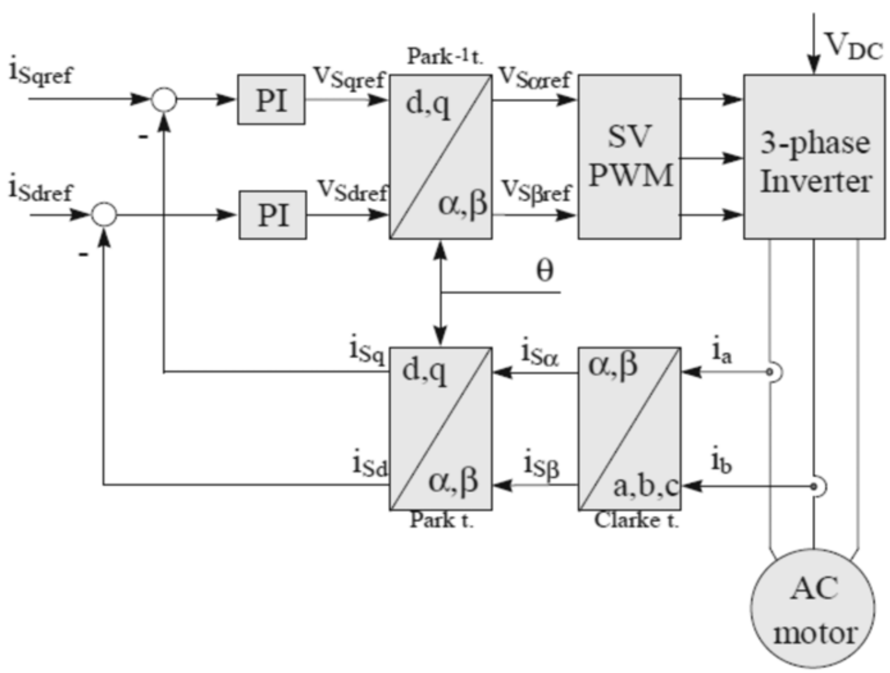

Fig.1. Basic Scheme of FOC for AC Motor.

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In FOC, mutually the enormity & phase of every one phase current ,voltage is the key of vector control. Three essential points on which FOC is based are

A. The machine current & voltage distance vectors
B. Conversion of a three phase speed & time reliant system into a two synchronize time consistent scheme
C. Effectual pulse thickness inflection design creation.

Due to these points, negative aspects of dc machine can be overcome by the control of ac machine at the same time the shortcoming of mechanical commutation can be excluded. Because of these control structure,it gained a correct steady state & transient control above excellent recital in response times & power conversion. Representing by a vector,FOC comprises of managing or controlling the stator currents.

The method in which the decoupling takes place between the components of current which is required to generate torque & magnetising flux. Induction motor can be acted simply as a dc motor because of the decoupling. Conversion between the coordinates from the fixed reference stator frame to the frame of revolving synchronous is done in vector control. Hence because of the exchange, separation of stator current is moulded into two components which are liable for the generation of torque & magnetising flux.

2. SIMULATION MODEL

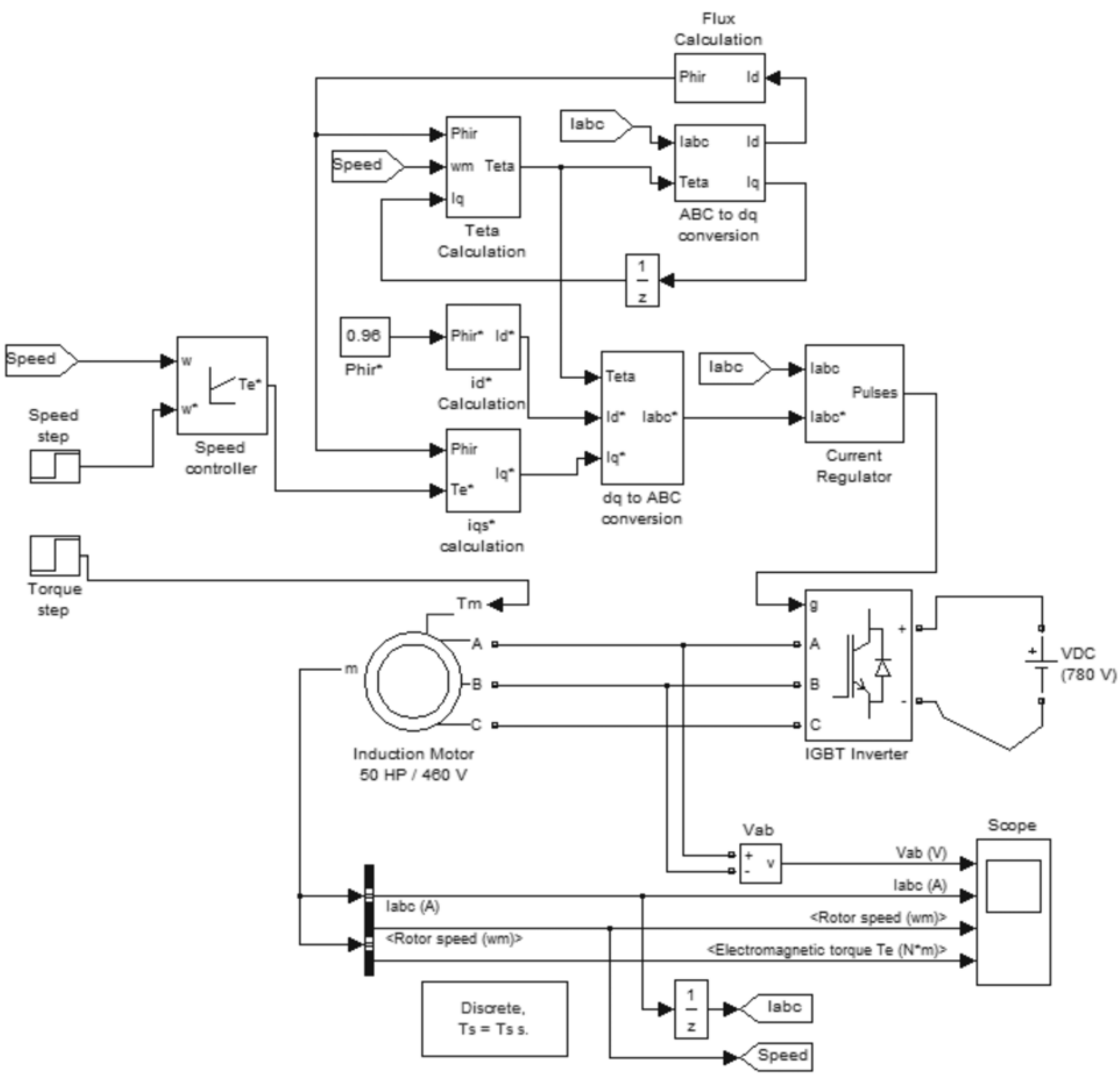

Fig. 2. Block Diagram of Vector or FOC Control Method.

Getting a ripple free output speed is the main purpose of this simulation model.. According to the need of appliances ,we need to vary the speed as well as the torque. For measuring the speed & torque different devices are used namely inverter, PI regulator, induction motor. In this model firstly there is no load on the motor and after sometime electromagnetic torque is generated. Firstly , the motor is run on no load ,so the initial value of torque is zero. Than load is increase up to 200 *i.e* final value .This value is known as electromechanical torque Now, stator current viz ia,ib,ic are converted into two axis system *i.e.* $i\alpha$ and $i\beta$. Conversion of iá and iâ is known as CLARKE TRANSFORMATION in which stator current ia,ib,ic are transform to two reference frame *i.e* $i\alpha$ and $i\beta$. Than the $i\alpha$ and $i\beta$ are again converted to *id* and *iq* variables *i.e* direct axis current and quadrature axis current which is called as PARK RANSFORMATION. Again id and iq quantities are reconverted to *a,b,c* phase variables by INVERSE PARK TRANSFORMATION. Hysteresis bandwidth modulation technique is used in current regulator .It compares the actual value of current with reference current and provide sinusoidal output current of proper frequency .If the current goes up to above limit than first switch is switched off. Similarly ,if the current goes to the lower strength than downward switch is switched off. Reference current follow the actual value of current inside the hysteresis band. Inverter perform its operation by triggering the gate signal of the inverter by match up to reference voltage to actual voltage and provides apt voltage.This method will provide THD *i.e* total harmonic distortion up to 14.55 which is very less compared to other techniques of speed control.At the same time ripples in speed is reduced to a great extent .Henceforth the method of FOC is preferred over other method of speed control.

3. EXECUTION OF SIMULATION MODEL

1. The reference generator speed & the actual speed is compared by speed regulator & engender error command to give the torque *te**. Current-controlled PWM inverter, which perform as a three-phase sinusoidal current supply.

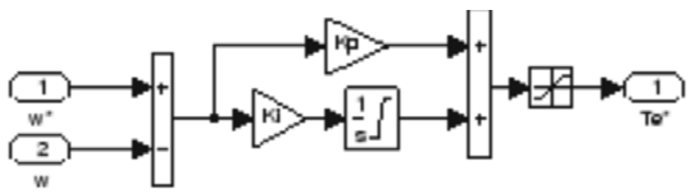

Fig. 3. Subsystem for Torque.

2. The stator quadrature-axis current reference i_{qs}* is considered from torque reference T_e* as

$$i_{qs}^* = \frac{2}{3}\cdot\frac{2}{p}\cdot\frac{L_r}{L_m}\cdot\frac{T_e^*}{|\psi_r|_{est}}$$

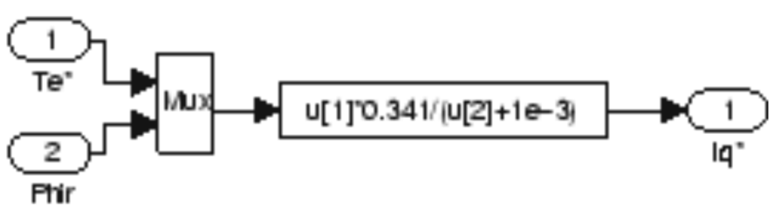

Fig. 4. Subsystem for Iq.

where L_r is the rotor inductance
L_m is the mutual inductance
$|\psi_r|_{est}$ is the projected rotor flux linkage

Which is given by $$|\psi_r|_{est} = \frac{L_m i_{ds}}{1+\tau_r s}$$

where $\tau_r = L_r / R_r$ is the rotor time invariable.

3. The stator direct-axis current reference i_{ds}* is produce from rotor flux reference input $|\psi_r|^*$.

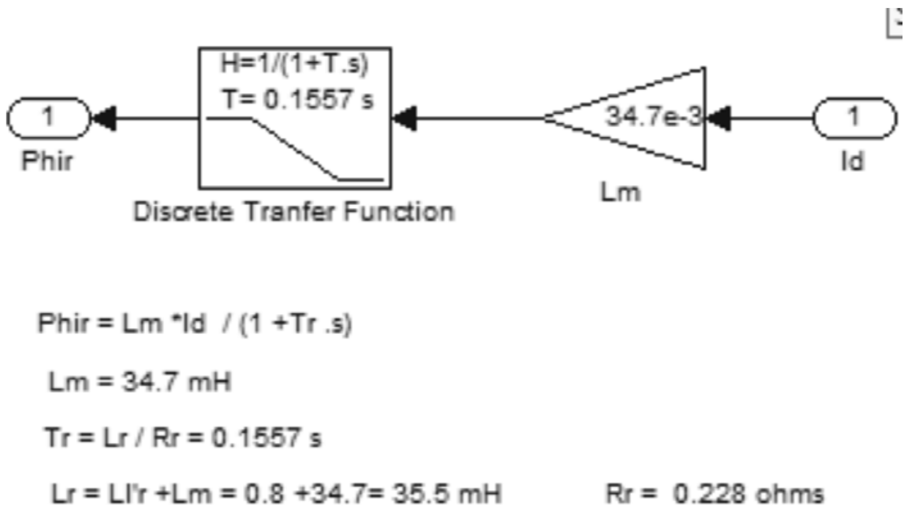

Fig. 5. Subsystem for ID.

$$i_{ds}^* = \frac{|\psi_r|^*}{L_m}$$

4. For coordinates transformation, the rotor speed ω_m and slip frequency ω_{sl} create the rotor flux position $\Theta\cup_e$

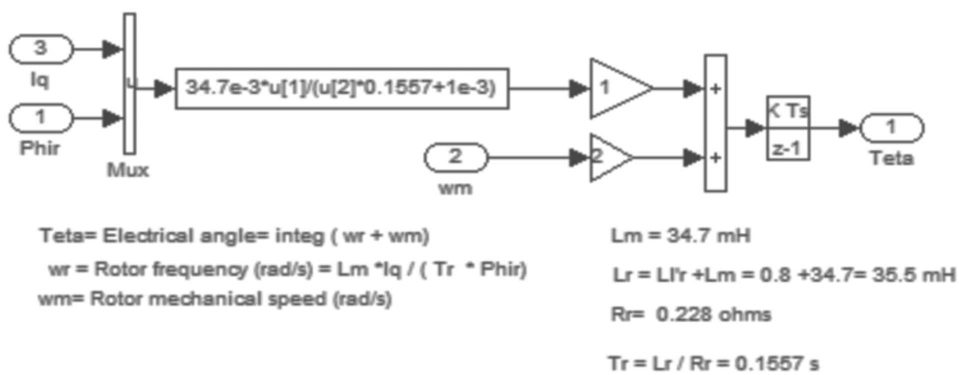

Fig. 6. Subsystem for Calculating Θ.

$$\theta_e = \int(\omega_m + \omega_{sl})dt$$

5. slip frequency is intended from the stator reference current i_{qs}* and the motor values.

$$\omega_{sl} = \frac{L_m}{|\psi_r|_{est}} \cdot \frac{R_r}{L_r} \cdot i_{qs}^*$$

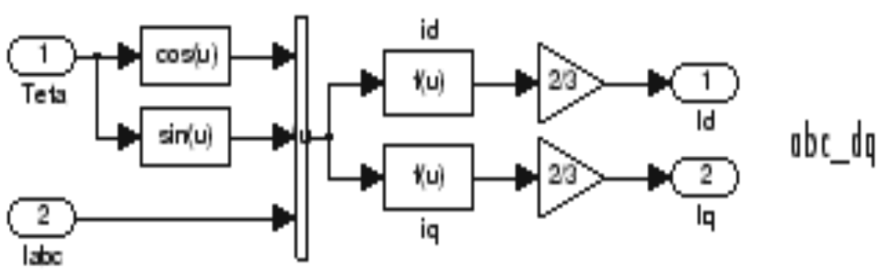

Fig. 7. Subsystem for Calculating Id * Iq.

6. **ABC TO DQ TRANSFORMATION :** Current references i_{qs}* and i_{ds}* are renewed into i_a*, i_b*, i_c* which are pulse current references. The function of current regulator is to calculate the reference & evaluate quantity to generate gating signals of inverter .To maintain the speed of the motor equivalent to reference speed is the job of speed regulator.

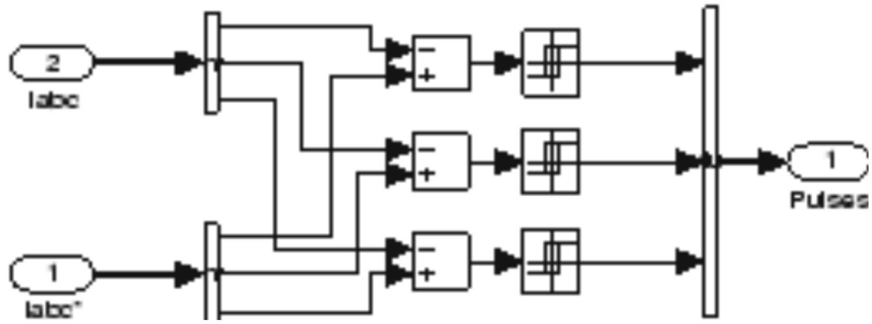

Fig. 8. Subsystem for Converstion of Current Into Inverter Pulse.

7. The checker can be a proportional-integral type for Steady state and to bestow a proficient in transients and dynamic

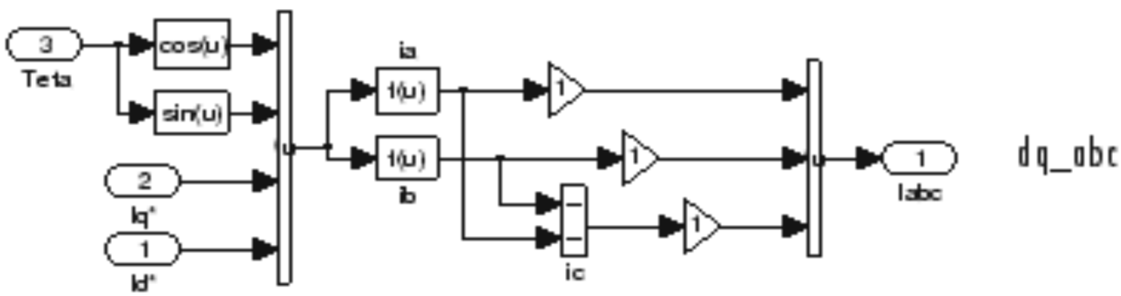

Fig. 9. Subsystem for Calculating Three Phase Current.

4. SIMULINK RESULTS

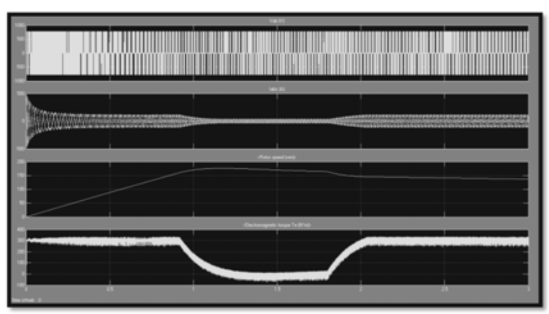

Fig. 10. Parameter Result 1.

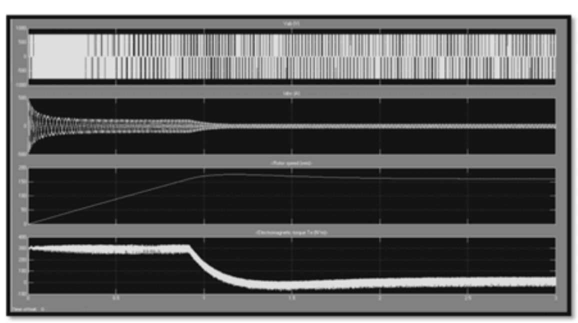

Fig. 11. Parameter Result 2.

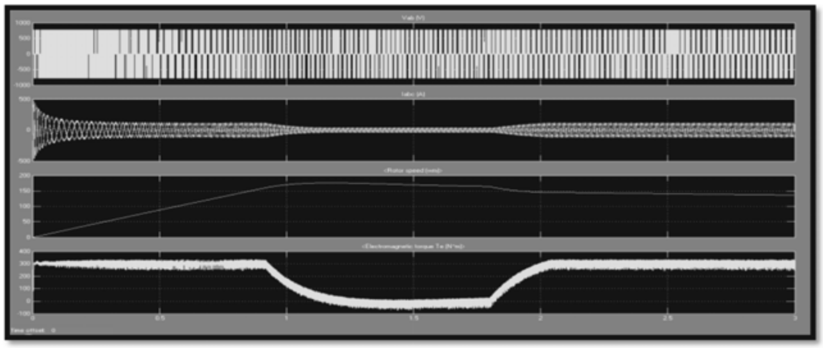

Fig. 12. Parameter Result 3.

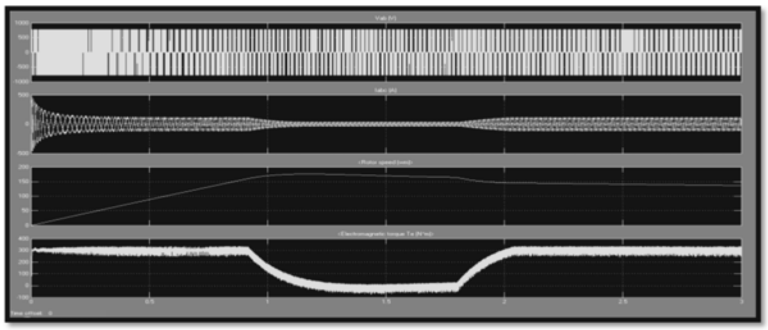

Fig. 13. Parameter Result 4.

In all above results ,torque & speed are varying inversely.when there is a load on motor, current is low for that period in all waveform. We know that as speed is inversely proportional to torque, which is visible in output waveform.

Table 1. Speed Results.

Waveform	*Step Time*	*Preliminary Value*	*Trial Value*
1.	0.2	120	160
2.	0.2	150	160
3.	0.2	120	200
4.	0.2	150	200

Table 2. Torque Results.

Waveform	*Step Time*	*Preliminary Value*	*Absolute Value*	*Trial Value*
1.	1.8	300	0	-1
2.	1.8	0	300	-1
3.	1.8	0	300	-1
4.	1.8	300	0	-1

5. CONCLUSION

FOC is the most renowned technology used for speed control of induction machine. As per need we can manage the speed & the desired results are generated. This technique proves beneficial over direct or scalar control technique which provide sluggish output and incorrect waveform. The most common application of foc technique is used in washing machine, where variety of clothes required diverse kind of speed & torque. Execution of various parameter ,simulation of stator current ,torque & flux is calculated ,compare and desired output results is generated.

6. REFERENCES

1. Field Orientated Control of 3-Phase AC-Motors Texas Instruments.
2. Bose, B. K. "*Modern Power Electronics and AC Drives*", Prentice-Hall, N.J., 2002.
3. Blaschke, F. 1972. "The Principle of Field Orientation as Applied to the New Transvector Closed Loop Control for Rotating Machines", Siemens Rev., Vol. 39, No. 5, pp. 217-220.
4. Correa, M.B.R., et al. 1998. "Field Oriented Control of a Single-Phase Induction Motor Drive", in Conf. Rec. Power Electronics Specialists, PESC'98, Fukuoka, Japan, Vol. II, pp. 990-996.
5. Trzynaldowski, A.M. 1994. "The field Orientation Principle in Control of Induction Motors",Kluwer Academic Publishers, Amsterdam.
6. Xu, X., et al. 1988. "A Stator Flux Oriented Induction Machine Drive", in Conf. Rec. Power Electronics Specialists, PESC'88, Kyoto, Japan, pp. 870-876.
7. R. Di Gabriele, F. Parasiliti, M. Tursini, "Digital Field Oriented Control for induction motors: implementation and experimental results", Universities Power Engineering Conference (UPEC'97).
8. A. Ometto, "Modulation Techniques", Università degli Studi di L'Aquila.
9. Vas, P. 1990. "Vector Control of AC Machines", Oxford University Press, Oxford.
10. Vas, P. 1992. "Electrical Machines and Drives", Oxford University Press, Oxford.
11. Sandeep Goyat Rajesh kr.Ahuja 2012 "Speed Control of Induction Motor using Vector Or Field Oriented Control"in International Journal of Advances in Engineering an Technology, Faridabad, Haryana ,pp-2231-1963.