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Simulation of Three Phase Induction Machine

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Abstract. Three phase induction motor is the most popular type AC motor. it is very commonly used for industrial drives. It is cheap, robust, efficient and reliable. It has good speed regulation and high starting torque. It requires little maintenance. It has a reasonable over load capacity. This paper deals with the simulation of three phase induction machine using MATLAB Simulink. The results are obtained for generating mode and motoring mode.

Keywords: simulation model, three phase induction machine, MATLAB.

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Моделирование трехфазной асинхронной машины

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Аннотация. Трехфазный асинхронный двигатель является наиболее популярным типом двигателя переменного тока. Он очень часто используется для промышленных приводов. Это дешево, прочно, эффективно и безотказно. Он обладает хорошей регулировкой скорости и высоким пусковым моментом, не требует особого ухода, обладает разумной перегрузочной способностью. Данная статья посвящена моделированию трехфазной асинхронной машины с использованием MATLAB Simulink. Результаты получены для режима генерации и режима движения.

Ключевые слова: имитационная модель, трехфазная асинхронная машина, MATLAB.

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1. Introduction

The three phase induction motor is the most widely used electrical motor. Almost 80 % of the mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating characteristics, absence of commutator and good speed regulation. In three phase induction motor, the power is transferred from stator to rotor winding through induction. The Induction motor is also called asynchronous motor as it runs at a speed other than the synchronous speed. Like any other electrical motor induction motor also have two main parts namely rotor and stator [1, 2].

Stator: As its name indicates stator is a stationary part of induction motor. A stator winding is placed in the stator of induction motor and the three phase supply is given to it.

1. Rotor: The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft.

The rotor of the three phase induction motor are further classified as

1. Squirrel cage rotor,
2. Slip ring rotor or wound rotor or phase wound rotor.

Depending upon the type of rotor construction used the three phase induction motor are classified as [3]:

1. Squirrel cage induction motor,

Slip ring induction motor or wound induction motor or phase wound induction motor.

The construction of stator for both the kinds of three phase induction motor remains the same. The other parts, which are required to complete the induction motor, are [4]:

1. Shaft for transmitting the torque to the load. This shaft is made up of steel.
2. Bearings for supporting the rotating shaft.
3. One of the problems with electrical motor is the production of heat during its rotation. In order to overcome this problem we need fan for cooling.
4. For receiving external electrical connection, terminal box is needed.
5. There is a small distance between rotor and stator which usually varies from 0.4 mm to 4 mm. Such a distance is called air gap.

2. Modeling of three phase induction machine using MATLAB Simulink

The model of three phase induction machine is shown in Fig. 1. This machine is designed in MATLAB Simulink and tested in generating mode and motoring mode.

a- In generating mode: applying positive mechanical torque to the rotor and the result is negative electromotive torque**.**

b- In motoring mode: applying negative mechanical torque constant load to the rotor and the result is positive electromotive torque**.**

2.1. Implementation of the rotor circuit

The detail of rotor block is shown in Fig. 2

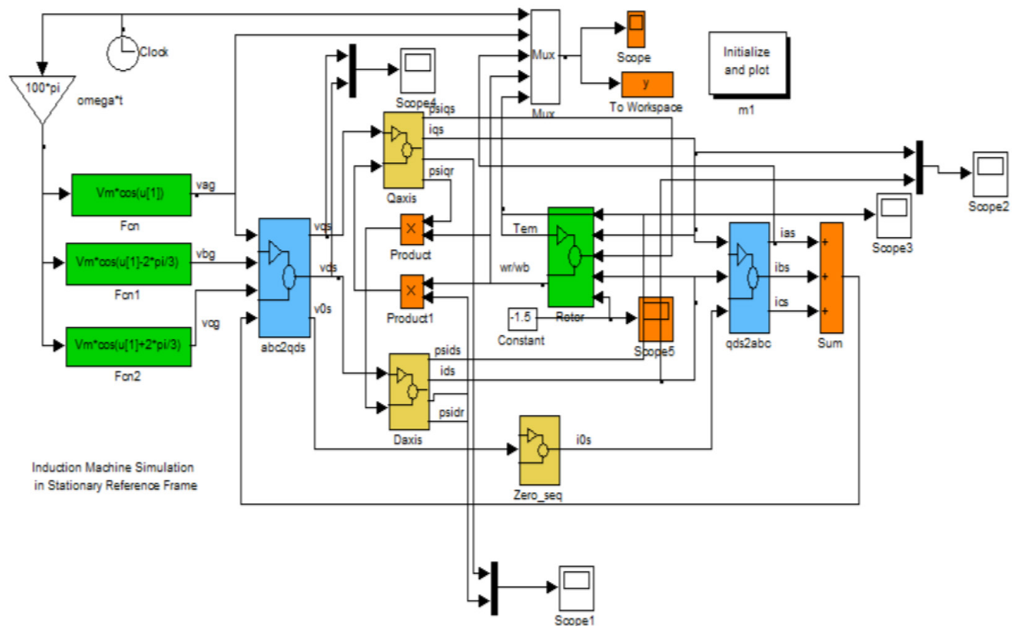

Fig. 1. Model of three phase induction machine in MATLAB

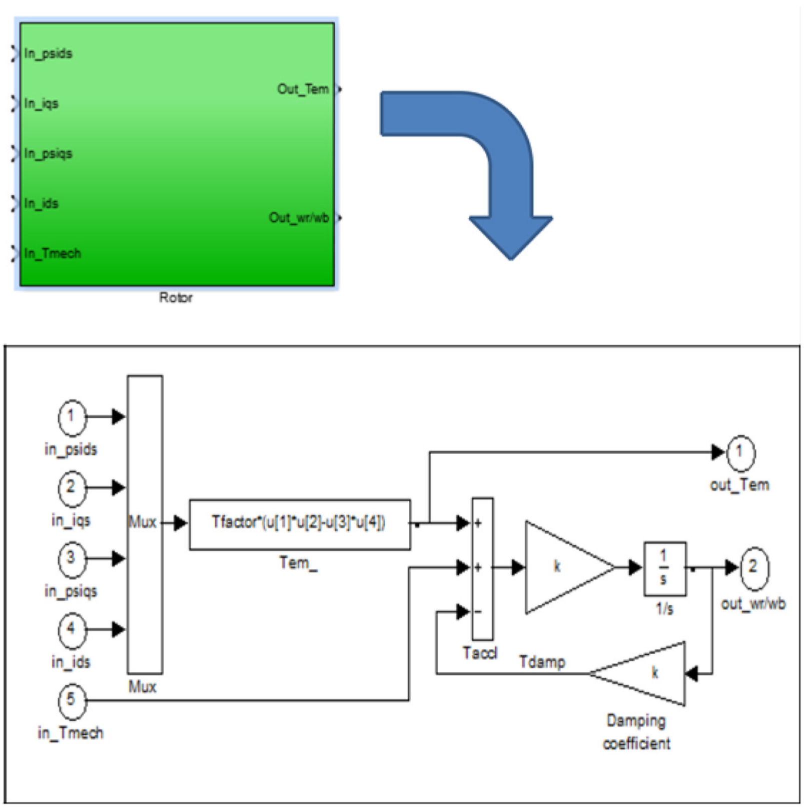

Fig. 2. Inside rotor block

2.2. Modeling of the transformation block

2.2.1. The transformation block (abc to dq)

The transformation block (abc to dq) is illustrated in Fig. 3.

2.2.2. The transformation block (dq to abc)

The transformation block (dq to abc) is illustrated in Fig. 4.

2.3. Modeling of the DQ0 blocks

2.3.1. D_axis block

The D_axis block is shown in Fig. 5.

2.3.2. Q _axis block

The Q_axis block is shown in Fig. 6.

2.3.3. 0_axis block

The 0_axis block is shown in Fig. 7.

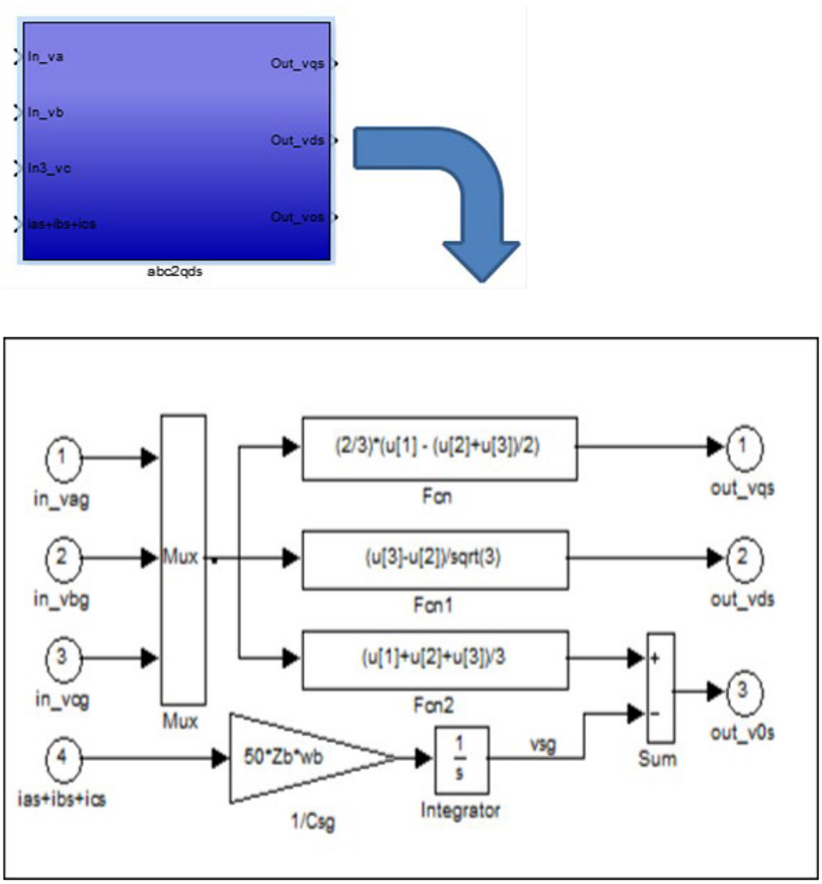

Fig. 3. The transformation block (abc to dq)

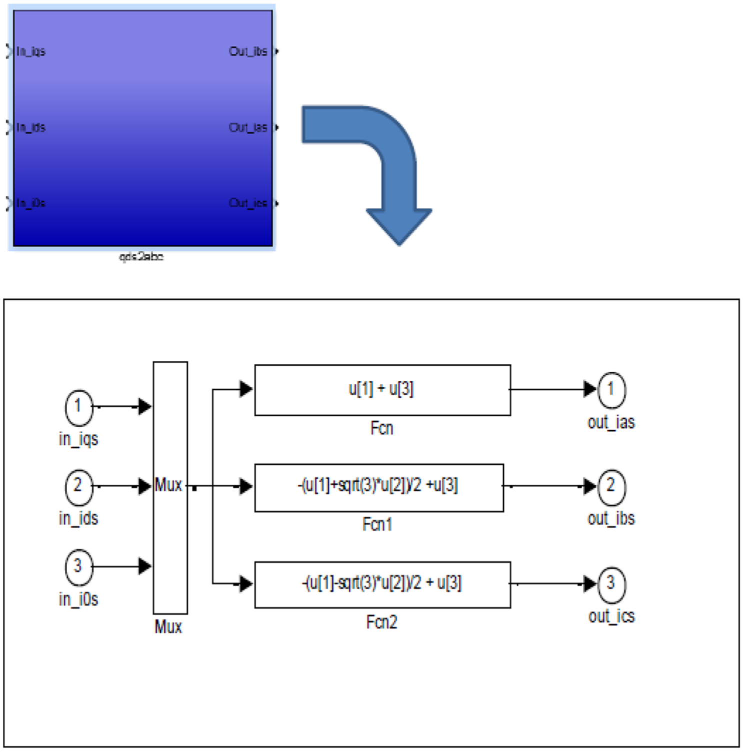

Fig. 4. The transformation block (dqs to abc)

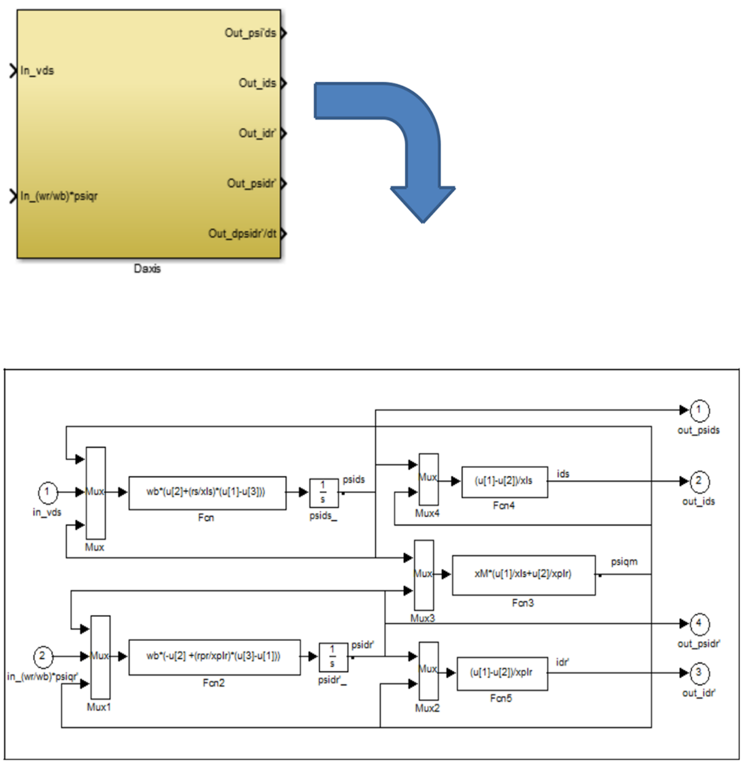

Fig. 5. Inside d_axis block

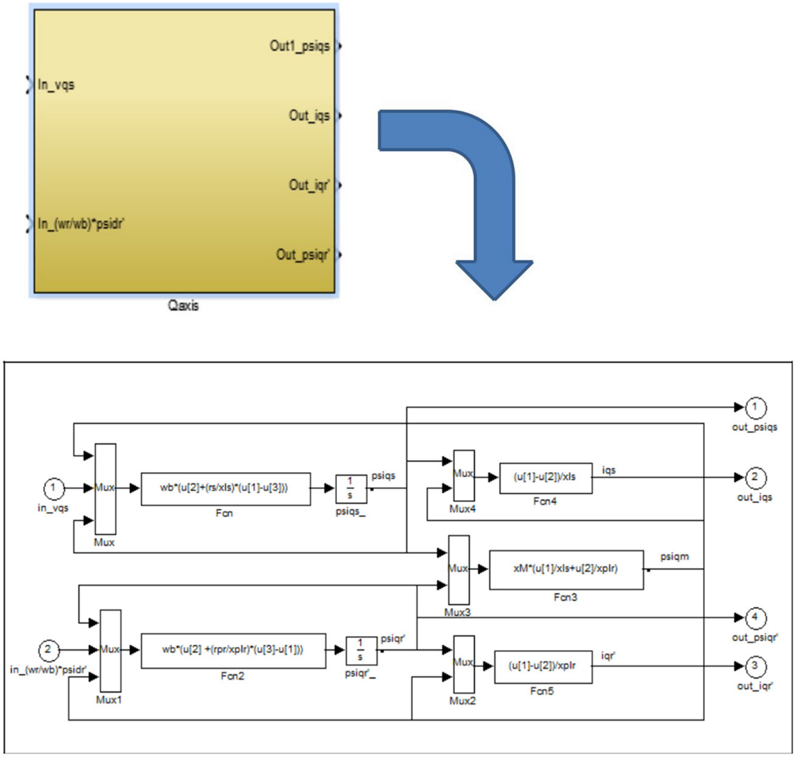

Fig. 6. Inside q_axis block

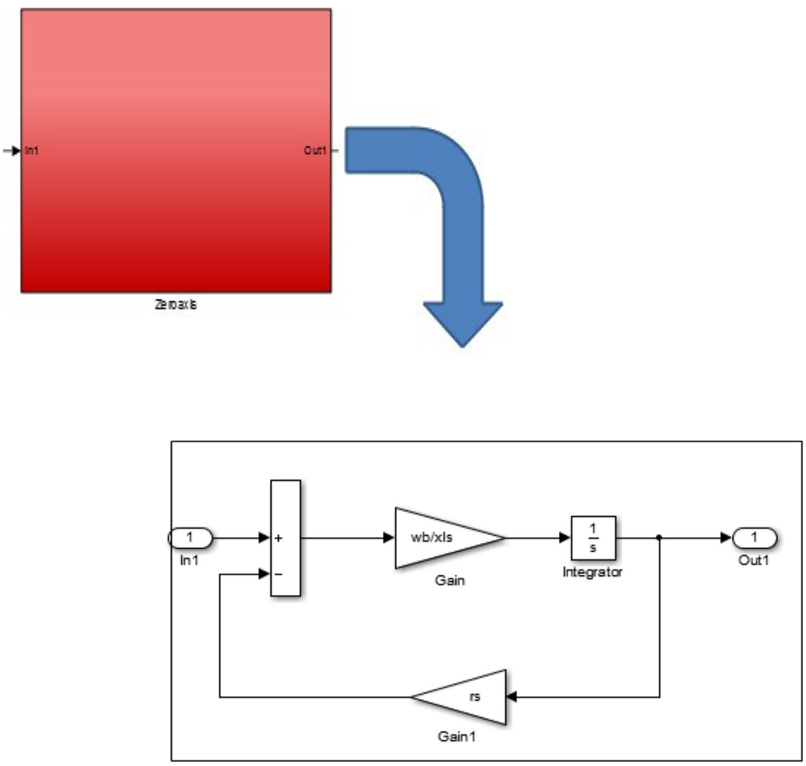

Fig. 7. Inside 0_axis block

3. Simulation results

The simulation results of (1HP, three phase, 50hz, four pole, 220v, R_s=3.35 ohm, R_r =1.99 ohm, L_{ls} = L_{lr} = 6.94 mH, L_m=163.73 mH, Jrotor =0.1 kgm^2, Tm= constant value (1.5), damping torque=0), are given below.

1-The stator voltages and currents in stationary reference frame are shown in Fig. 8 & Fig. 9, and the angle between *d* and *q* is (90 degree).

2-The rotor currents in stationary reference frame are shown in Fig. 10.

3-Fig. 11 shows the electromotive torque (T_{em}) is negative which means the machine in generating mode.

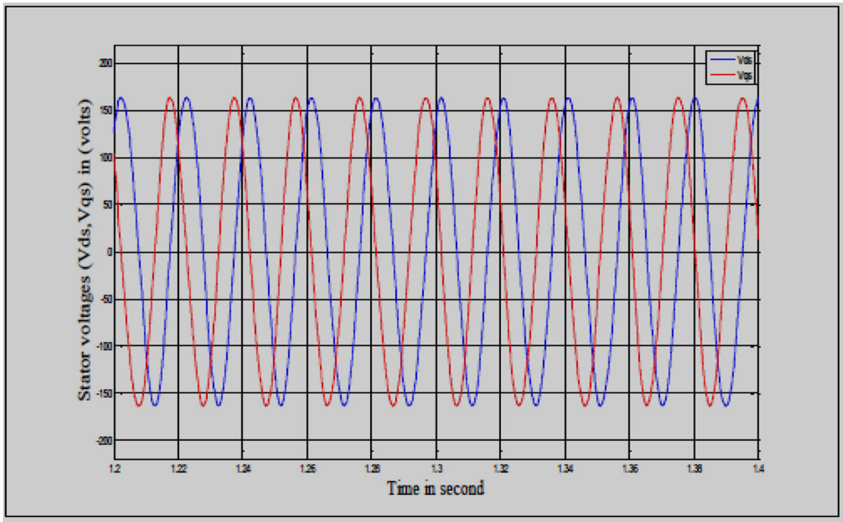

Fig. 8. Stator dq voltages

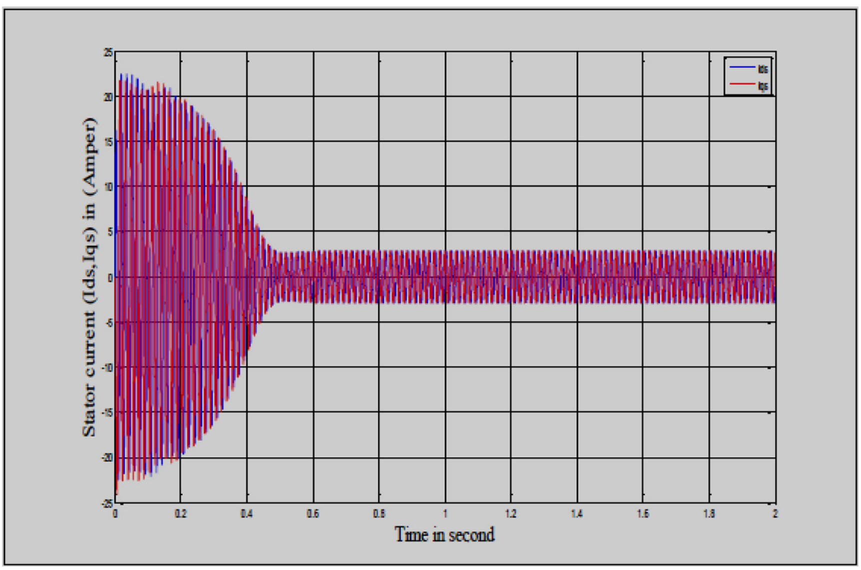

Fig. 9. Stator dq currents

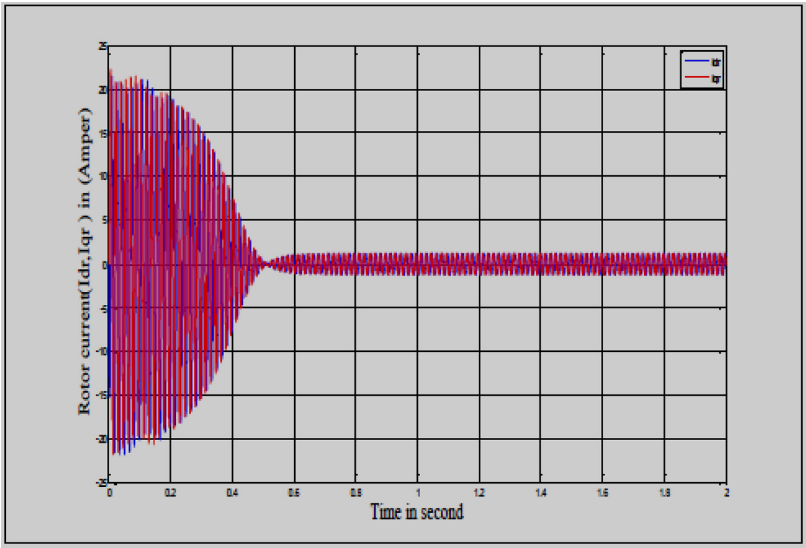

Fig. 10. Rotor dq currents

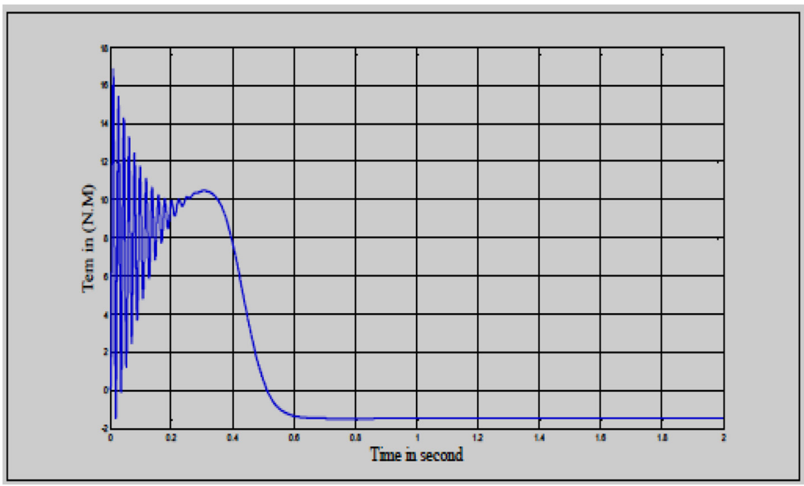

Fig. 11. The electromotive torque(Tem) in generating mode

4-Fig. 11 shows the electromotive torque (T_{em}) is positive which means the machine in motoring mode.

5-The ids & iqs currents of stator are shown in Fig. 13 and Fig. 14.

6-The psids & psiqs currents of stator are shown in Fig. 15, and Fig. 16.

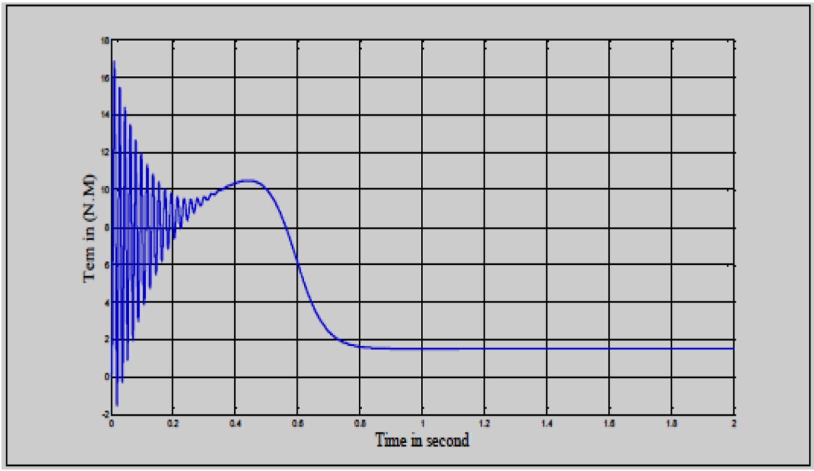

Fig. 12. The electromotive torque(Tem) in motoring mode

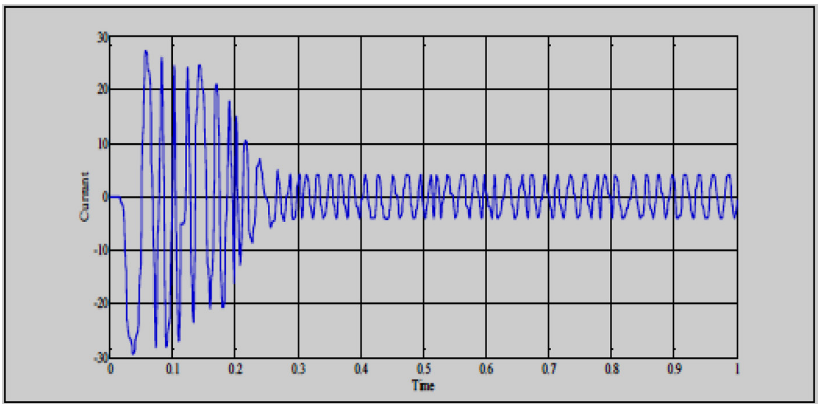

Fig. 13. Ids current

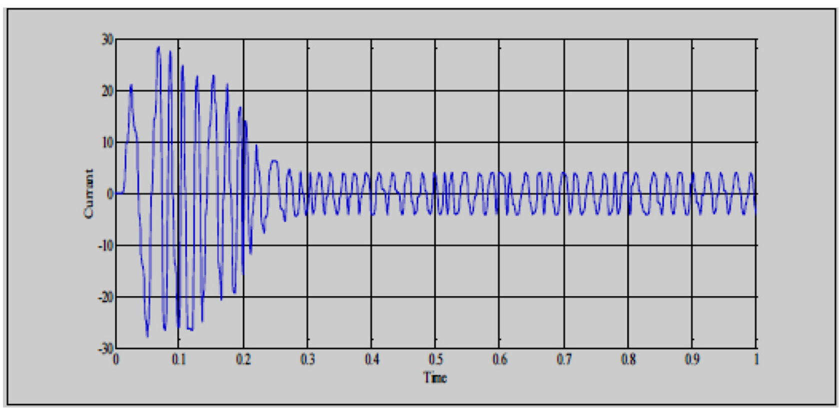

Fig. 14. Iqs current

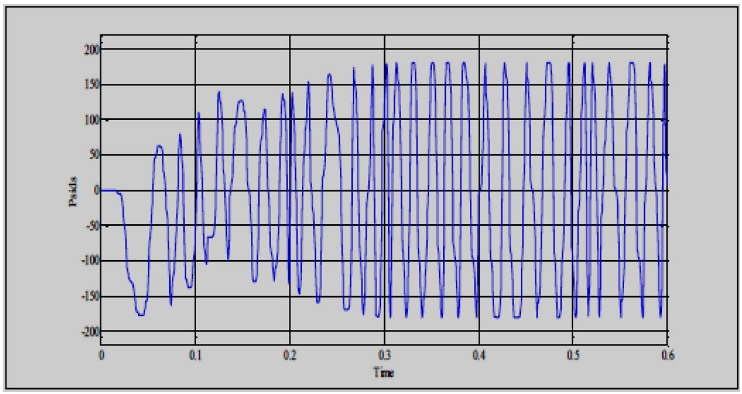

Fig. 15. Psids current

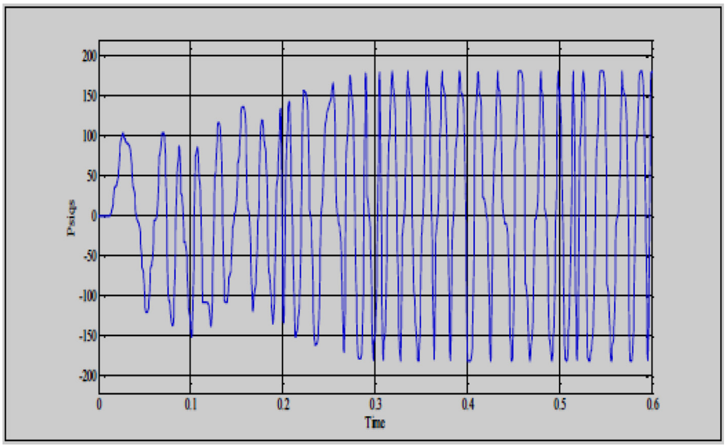

Fig. 16. Psiqs current

4. Conclusion

The simulation model of three phase induction machine is implemented and designed using MATLAB Simulink. The model can operate as generator or motor depending on the input torque. If the input torque is negative, then the model behaves as generator, and if the input torque is positive, then the model behaves as motor.

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