**NAME: Kode Alison Mudiaga**

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**DEPARTMENT: Mechanical Engineering**

**COURSE TITLE: Electrical Machines II**

**COURSE CODE: EEE326**

**ASSIGNMENT**

1. A 6-Pole, 50Hz, 3 Ø slip ring induction motor has a resistance of 0.5Ω per phase and a reactance of 5Ω per phase in the rotor state. Calculate;
* The speed at which the torque is at maximum
* The ratio of the starting torque to the maximum torque
* Value of the external resistance per phase needed so that the starting torque is half of the max torque

**Solution**

* Rotor resistance per phase R2=0.5Ω

Rotor standstill reactance per phase X2= 5Ω

Torque under running conditions is maximum at the value of slip

Slip corresponding to maximum torque, Smax= R2÷X2= $\frac{0,5}{5}$= 0.1

Speed corresponding to maximum, N=NS= (1-Smax)

 = $\frac{120F}{P}$[1-Smax] = $\frac{120×50}{60}$[1-0.1] = 900rpm

* Ratio of rotor resistance to rotor standstill resistance

 a= R2÷X2 = $\frac{0.5}{5}$= 0.1

Ratio of $\frac{Maximum torque}{Starting torque}$ = a2+1/2a = (0.1)2+1/2(0.1) = 5.05

* Ratio of starting torque Tst and maximum torque Tmax

Tst/Tmax = 2a/a2+1 = 0.5 whereby earlier a = 0.1

 Where Tst = $\frac{1}{2}$Tmax

Then a2-4a+1=0

a = $\frac{4\pm \sqrt{16}-4}{2}$= 0.268

If the torque is half the normal value then

R2+r/X2 = 0.268

Making r subject of formula

r = 0.268X2-R2 =(0.268 × 5) – 0.5 = 0.84Ω

1. The starting and max torque of a 3 – Ø induction motor are 1.5 and 2.5 times its full load torque respectively. Determine the percentage change in the rotor circuit resistance to obtain a full load slip of 0.03. Neglect the stator impedance

**Solution**

Starting torque Tst = 1.5T

Maximum torque Tmax = 2.5T

 Tst/ Tmax = 1.5/2.5 = 0.6

 3a2-10a+3=0

(3a-1)(a-3)=0

a=$\frac{1}{3}$

 R2/X2= a = $\frac{1}{3}$

Rotor resistance R2 = $\frac{1}{3}$ X2

TF ÷ Tmax = 2aSf ÷ a2+Sf2

1 ÷ 2.5 = 2a×0.03/a2+(0.03)2

Tmax = 2.5T , SF= 0.03

a2- 0.15a + 0.0009 = 0

a = $\frac{0.15\pm \sqrt{0.0225}-4×0.0009}{2}$ = 0.1437 feasible answer

Percentage reduction =  = 56.9%

1. A 3- Ø, 50Hz induction motor has a starting torque which is 1.25 times full load torque and a maximum torque which is 2.5 times full load torque. Neglecting stator resistance and rotational losses and assuming constant rotor resistance. Calculate
* The slip at full load
* Slip at maximum torque
* Rotor current at starting in per unit of full load rotor current

**Solution**

Starting torque Tst= 1.25T

Maximum torque Tmax = 2.5T

Tst / Tmax = 2a/a2+1 = $\frac{1.25}{2.5}$= 0.5

= a2-4a+1 = a= $\frac{4\pm \sqrt{16}-4}{2}$ = 0.268 Tf / Tmax = 2aSf / a2+SF2

1/2.5 = 2×0.268/(0.268)2+Sf2

Sf2-1.34Sf+0.0718=0

* Full load slip Sf = $\frac{1.34\pm \sqrt{1.7956}-4×0.0718}{2}$ = 0.056 = 56%
* Smax= a = 0.268 = 26.8%
* Rotor current at stator

Ist= 

Rotor current at full load

If = 



= 



1. A 3-Ø, 4 pole , 50Hz induction motor at standstill has 120v induced across its star-connected terminals. The rotor resistance and standstill resistance per phase are 0.2 and 1.0Ω respectively. Calculate the speed when the rotor is drawing a current of 16A at particular load, also calculate the speed at which the torque is at the corresponding value of rotor input.

**Solution**

I2 =  where R2 = 0.2 and X2 = 1.0 Ω , E2 = $\frac{120}{√3}$ , I2 = 16

making s subject and imputing all the values

then s= 0.04747

motor speed N= Ns(1-S) = $\frac{120f}{p}$(1-s) = $\frac{120f}{p}\left[1-0.04747\right]$ = 1.420rpm

Smax = R2/x2 = 0.2/1 = 0.2

Slip corresponding to the torque N= Ns(1-Smax) = $\frac{120f}{p}$(1-s) = $\frac{120×50}{4}[1-0.2]$ = 1,200rpm

Rotor impedance Z2 = 

= 

Induced Emf in rotor per phase = SE2 = 0.2 × $\frac{120}{√3}$ = 13.856v

 Rotor current per phase I2 =  = $\frac{13.856}{0.283}$ = 49A

Power factor of rotor circuit, cosØ2 =  = 

Power supplied to rotor = Ø2

= 