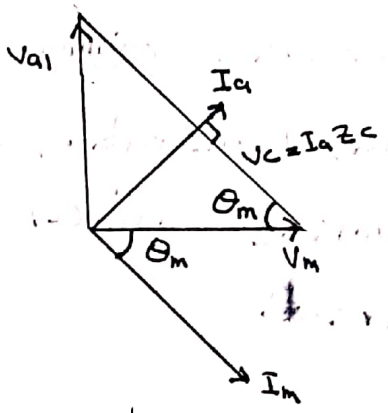
When $I_m = -J a I_a$ ($T_b = 0$) and $\alpha = 90^\circ$ the motor will operate in a balanced conditions:-



$V_a = V_m$

$V_{a1} = V_a - V_c$

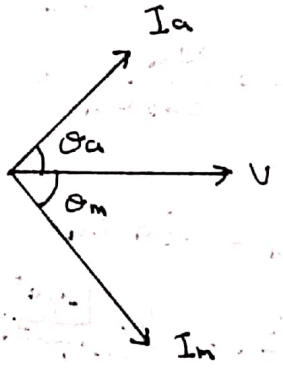
$\tan\theta_m = \frac{V_{a1}}{V_m}$

$I_{in} = I_m + I_a$

$a = \frac{V_{a1}}{V_m}$, $a = \tan\theta_m$.

Example: Find the value of the starting capacitance for a 250W, 120V, 60 Hz induction motor that will place main and auxiliary winding currents in quadrature at starting. At standstill, motor input impedance through the main and the auxiliary windings are $(4.5 + j3.7)\ \Omega$ and $(9.5 + j3.5)\ \Omega$ respectively.

solution



$\theta_m = \tan^{-1}\frac{3.7}{4.5} = 39.4^\circ$

$\theta_a + \theta_m = 90^\circ$

$\therefore \theta_a = 90^\circ - \theta_m = 90 - 39.4^\circ$

$= 50.6^\circ$

$\tan\theta_a = \frac{X_c - 3.5}{9.5}$

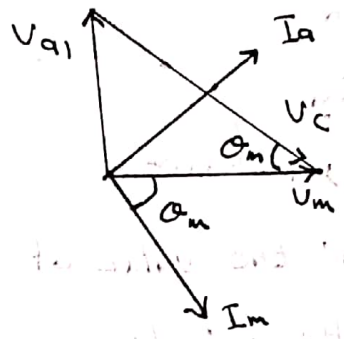
$\Rightarrow X_c = 9.5 \tan\theta_a + 3.5$

$= 9.5 \tan 50.6 + 3.5$

$= 15.07\ \Omega$

$15.07 = \frac{1}{2\pi \times 60 C} \Rightarrow C = 176\ \mu f$

Example: A 230V, 50Hz, capacitor-run motor has a main winding which takes a current of 23A at 0.5 lagging power factor when running under balanced conditions. Calculate (a) turns ratio, (b) the capacitance and capacitor voltage and (c) the power factor of the input current.



Solution

(a)

$\theta_m = \cos^{-1} 0.5$

$= 60^\circ$

$\tan\theta_m = \frac{V_{ai}}{V_m}$, $a = \tan\theta_m = \tan 60 = \sqrt{3}$

(b)

$\cos\theta_m = \frac{V_m}{V_c}$

$V_c = \frac{V_m}{\cos\theta_m} = \frac{230}{\cos 60} = 460\,V$

$I_m = -ja\,I_a \Rightarrow I_a = \frac{I_m}{ja}$

$\therefore I_a = \frac{23}{\sqrt{3}}$

$X_c = \frac{V_c}{I_a} = \frac{460}{23/\sqrt{3}} = 34.6\ \Omega$

$34.6 = \frac{1}{2\pi \times 50 C} \Rightarrow C = 92\ \mu f$

(c) $I_m = 23\angle -60^\circ = 11.5 - j\,19.92\ A$

$I_a = \frac{23}{\sqrt{3}}\angle 90^\circ - 60^\circ = \frac{23}{\sqrt{3}}\angle 30^\circ = 11.5 + j\,6.64\ A$

$I_{in} = I_m + I_a = 23 - j\,13.23 = 26.5\angle -30^\circ \Rightarrow p.f = \cos 30^\circ$ lagging