Assignment 2

Q1) A 440 V, 3 phase, 50 Hz, 6 pole, 945 rpm star connected induction motor has following parameters:

$r_1 = 0.0\ \Omega$ (approx), $r_2' = 2.0\ \Omega$, $x_1 = 0.0\ \Omega$ (approx), $x_2' = 0.0\ \Omega$(approx) .

Neglect the effect of $X_m$ and rotational losses. The motor is operated from an ac source whose frequency is constant and is equal to 50 Hz.

i) Determine the required line to line voltage to be applied to the stator terminals of the motor for running the rated load at 800 rpm. The load torque is independent of speed.

ii) By what percentage the load torque is to be reduced, so that the motor can run at 800 rpm continuously without overheating and what is the voltage that needs to be applied now to the stator terminals of the motor? Neglect rotational losses.

Q2) A 440V, three phase, 50Hz, 4 pole, 1420 rpm delta connected induction motor has following parameters: $r_1 = 0.0\Omega$ (approx), $r_2' = 0.4\Omega$, $x_1 = 0.0\Omega$ (approx) , $x_2' = 0.8\Omega$. Neglect the effect of $X_m$ and rotational losses. The motor is fed from a voltage source inverter. The drive is operated with a constant v/f control up to 50 Hz and at rated voltage and variable frequency above 50 Hz. The motor is negotiating a constant load torque (not a function of speed) whose magnitude is 485 Nmt. What should be the magnitude and frequency of the terminal voltage of the motor to run the load at 700rpm? Neglect rotational losses.

Q3) A 440V, 50 Hz, 4 pole, 1420 rpm, delta connected squirrel cage induction motor has the following parameters per phase referred to the stator: $r_1 = 0.0\ \Omega$ (approx), $r_2' = 0.4\ \Omega$, $x_1 = 0.0\ \Omega$ (approx), $x_2' = 0.8\ \Omega$ and $X_m$ can be considered very large compared to other impedances. The motor is being fed by a voltage source inverter. Find what should be the values of the per phase machine voltage and frequency if the machine has to negotiate half the rated active load torque at 1500 rpm in the fourth quadrant. Neglect rotational losses.

Q4) An electric vehicle is driven by a 3-phase inverter fed 440V, 50 Hz, 3 phase, 4 pole, 1420 rpm, delta connected squirrel cage induction motor having the following per phase parameters referred to the stator: $r_1 = 0.0\ \Omega$ (approx), $r_2' = 0.4\ \Omega$, $x_1 = 0.0\ \Omega$ (approx), $x_2' = 0.0\ \Omega$ (approx) and $X_m$ can be considered very large compared to other impedances. The motor is controlled with V/f method and is coupled to the shaft of the front wheels by a gear. Neglect rotational and windage losses, and assume that the inverter voltages are perfectly sinusoidal.

a) The vehicle is running on a level road in a certain direction and the steady state speed of the motor is found to be 2000 rpm, and it is developing one fourth of the rated torque. Determine the magnitude (rms) of the inverter voltage and its frequency.

b) Subsequently the vehicle starts running down a hill in the same direction as that of a) and with the same speed i.e. 2000 rpm while developing braking torque which is equal to half of the rated torque of the machine. Determine the magnitude (rms) of the inverter voltage and its frequency.

Q5) The three phase inverter of the Figure (with switch MS open) is controlled with sinusoidal pulse width modulation and is feeding a star connected balanced three phase load, $Z_a = Z_b = Z_c$. The dc input voltage of the inverter, $V_d$ is 400 V. The frequency of the sinusoidal

modulating wave is 25 Hz and its amplitude is 0.5V. The frequency of the triangular carrier waveform is 2625 Hz and its amplitude is 1V. Plot the approximate harmonic spectrum of 1) pole voltage of the inverter, $v_{AO}$ and 2) line to line voltage of the inverter, $v_{AB}$ showing the numerical value of amplitude of the fundamental component (numerical value of amplitudes of other harmonic components need not to be shown however their locations on the spectrum should be shown). The x-axis of the spectrum should be graduated both in terms of frequency and harmonic number, and it should extend upto 25 kHz. Justify the presence of each harmonic component that you have shown in both the harmonic spectrums. No credit will be awarded if proper justification is not provided.