

College of Engineering, Pune

B.Tech- Electrical EE401- Electric Drives

Date- 25th Nov. 2012
Academic Year: 2012- 13

Timing: 3 hrs
Max. Marks: 100

Autumn Semester

MIS no									
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Important notes

- *Q1 is compulsory and you need to solve it in first 20 min. Use the space provided for answers. Put your MIS no and return the first page of the question paper to the invigilator after 20 min.*
- *Solve any Four questions from the remaining.*
- *All questions carry equal marks. Figures in bracket indicate marks for subquestions*

Set A

Q. 1	A	Give the most appropriate choice	Answer
	I	Which of the following power electronics circuit can be used as a four quadrant drive [a] H- Bridge inverter [b] Scheirbus Drive [c] Single phase dual converter [d] All of these	
	II	This drive has superior transient response [a] V/F control [b] Scheirbus Drive [c] Direct Vector control [d] Direct Torque Control	
	III	This method utilizes the available DC bus voltage to the best possible extent [a] SPWM [b] Third harmonic injected PWM [c] Space Vector modulation [d] Square wave mode of operation	
	IV	Which drive has maximum torque per unit ampere ratio [a] PMSM drive [b] BLDC drive [c] Induction motor drive [d] Synchronous reluctance motor drive	
	V	In which case the output V_{THD} of the inverter will be minimum [a] Free running SPWM [b] Synchronized SPWM using bipolar switching [c] Synchronized SPWM with unipolar switching [d] All of these	
	VI	In which reference frame, the stator quantities appear as dc quantities for induction motor [a] Stationary reference frame [b] Rotating reference frame attached to rotor [c] Synchronously rotating reference frame [d] none of these	

	VII	How many notches per cycle will be required to eliminate 5 th and 7 th harmonics from the output voltage waveform of a three phase inverter, having controllable fundamental voltage. [a] 15 [b] 09 [c] 12 [d] 06	
	VIII	Which of the following is suitable drive for lift motor [a] Shunt motor [b] Induction motor [c] PMSM [d] All of these	
	IX	In which case the field weakening mode of operation is relatively difficult [a] DC motor [b] V/F controlled induction motor [c] PMSM motor [d] Phase wound synchronous motor	
	X	Which of the following combination of the stator and rotor poles is not recommended for switched reluctance motors [a] 6/4 [b] 8/6 [c] 12/6 [d] 4/6	
	XI	A three phase three level inverter has following no of switching states [a] 8 [b] 16 [c] 27 [d] 32	
	XII	A industrial fan is running at 700 rpm. The speed of this fan is increased to 1400 rpm. The electrical power input will approximately increase by [a] 2 times [b] 4 times [c] 8 times [d] none of these	
	XIII	In a 5 level improved diode clamp inverter, ... no of dc capacitors and no of clamping diodes are required to form one leg of inverter [a] 4 and 12 [b] 5 and 10 [c] 4 and 10 [d] 5 and 12	
	XIV	A 2 MW induction motor fed boiler feed water pump is to be driven by VFD. Which of the following PWM method will you recommend [a] Space Vector modulation [b] SPWM [c] Selected harmonic elimination [d] Third harmonic injected PWM	
	XV	A 466 volts, 60 Hz, 5 hp induction motor is imported from US and installed in India and fed from 415 Volts, 50 Hz supply. If the motor is operated at rated load, what will happen to efficiency at rated load condition? [a] Efficiency will increase [b] Efficiency will decrease [c] No change takes place [d] Can not be predicted	
Q. 1	B	State whether the following statements are true or false	Answer
	I	Current source inverter fed drive has faster transient response than voltage fed inverter drive	
	II	BLDC back emf waveform is sinusoidal	
	III	BLDC is "true synchronous operation of the synchronous machine"	
	IV	Static Kramer drive offer the four quadrant operation	
	V	Synchronous reluctance motor is doubly salient machine	

Q. 2	a	A three-phase, 460-V, 60 Hz, 10 pole, Y-connected cylindrical rotor synchronous motor has a synchronous reactance of $X_s=0.8$ ohm per phase and the negligible armature resistance. The load torque which is proportional to the speed squared, is $T_L=1250$ N-m at 720 rpm. The power factor is maintained at 0.8 lagging by field control and the voltage to frequency ratio is kept constant at the rated value. If the inverter frequency is 45 Hz and the motor speed is 540 rpm, calculate [a] the input voltage [b] the armature current [c] the excitation voltage [d] the torque angle, and [e] the pull out torque [12]
	b	Derive the expression for pull out torque of synchronous reluctance motor[8]
Q.3		Starting from 3 phase stator winding and 3 phase rotor winding, step by step develop d-q model of induction motor in synchronously rotating reference frame and derive the expression for electromagnetic torque developed by the motor in terms of d-q axes currents and flux linkages.
Q.4	a	Compare Direct Torque Control with Vector control and explain how flux and torque are controlled in DTC giving suitable diagrams. [12]
	b	Give the block diagram of direct vector control with rotor flux orientation and briefly explain.[08]
Q.5	A	Write short notes on [Any Three] [12]
	I	Switched reluctance motor drive
	II	Cascaded H-Bridge multilevel inverter
	III	Static Kramer drive
	IV	Different classes of motor duties
	B	A motor equipped with a fly wheel has to supply a load torque of 600 N-m for 10 sec followed by a no load period long enough for the flywheel to regain its full speed. It is desired to limit the motor torque to 450N-m. What should be the moment of inertia of the flywheel? The no load speed of the motor is 600 rpm and it has a slip of 8% at torque of 400N-m. Assume the motor speed-torque characteristic to be a straight line in the range of operation. Motor has inertia of $10\text{Kg}\cdot\text{m}^2$. [08]
Q.6	a	Give the block diagram of closed loop V/F speed control drive and list out the salient features of V/F control [08]
	b	A three phase 460 V, 60 Hz, 6 poles, Y-connected wound rotor induction motor whose speed is to be controlled by slip power as shown in Fig. A , has following parameters; $R_s=0.041$ ohm, $R_r=0.044$ ohms, $X_s=0.29$ ohms, $X_r=0.44$ ohms and $X_m=6.1$ ohm. The turns ratio of the rotor to stator windings is $n_m=N_r/N_s=0.9$. The inductance L_d is very large and its current I_d has negligible ripple. The values of R_s , R_r , X_s , X_r are negligible compared to

		Ld. The losses in rectifier, inductor and switch are also negligible. The load torque which is proportional to speed squared is 750 N-m at 1175 rpm [a] If the motor has to operate with a minimum speed of 800 rpm, determine the resistance R. With this value of R, if the desired speed is 1050 rpm, calculate [b] the inductor current, [c] the duty factor of the converter [d] the dc voltage Vd [12]
Q.7	a	Consider an electric drive for an elevator with the data shown in Fig.B The motor speed is $n_n=1550$ rpm. The efficiency of the gearing system is 0.8. Calculate the total inertia on motor shaft, torque and power with and without the counter weight. [12]
	b	Develop a thermal model of motor for heating and cooling [08]

