TECHNICAL UNVERSITY OF MOMBASA

Faculty of Engineering & Technology in Conjunction with Kenya Institute of Highways and Building Technology (KIHBT)

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

HIGHER DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING

EEP 3203: SPECIAL ELECTRICAL MACHINES & DRIVES

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2014
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*
- *Electronic Calculator*
- *Drawing Instruments*

This paper consists of **FIVE** questions. Answer any **THREE** questions
All questions carry equal marks
Maximum marks for each part of a question are as shown

This paper consists of **THREE** printed pages

Question One

a) State TWO merits and ONE application of permanent magnet synchronous motor. **(3 marks)**

b) (i) With the aid of a sketch, explain the working of a Switched Reluctance Motor.

(ii) Explain any THREE benefits associated with the motor in b(i) above. **(7 marks)**

c) The rotor of a synchro is excited by a single phase AC voltage of r.m.s of value 120V. Assume stator rotor turn ration of unity and:

(i) Determine the corresponding stator voltage for rotor angles: $\alpha = +30^o \quad and \quad -30^o$ respectively

(ii) Find the terminal voltages when rotor angle $\alpha = +40^o$ **(10 marks)**

Question Two

a) (i) State any THREE differences existing between DC and AC drives.

(ii) Draw a labeled block diagram of a Thyristor Based DC Drive System. **(6 marks)**
(6 marks)

b) Show that for Field controlled DC servo motor the output speed $\omega(s)$ is related to input voltage $Vf_{(s)}$ through:

$$\frac{\omega(s)}{V_f(s)} = \frac{K_m f / L_f \; Jm}{\left(s + C/J_m\right)\left(s + Rt/L_f\right)}$$

(8 marks)

c) A 200V field controlled, separately excited servo motro is fed from a DC Chopper Drive whose toFF is constant for 30ms. Given the constant K_{mf} = 20; L_f = 500; J_m = 0.02; R_f = 1KΩ ; and C = 0.2. Determine Drive time toN required to turn the motor through angle $\theta = 5\pi$ radians.

Question Three

c) (i) State any THREE advantages of electric drives over mechanical counterparts.

(ii) List THREE merits of Gate Turn Off (G.T.O) devices over Thyristors in construction of Electronic Drives. **(6 marks)**

d) (i) Use a classification diagram to categorize Electric Drives according to sources

(ii) List any FOUR advantages of AC drives other DC **(6 marks)**

c) From the corresponding equivalent circuit show that the torque produced in variable voltz/Hertz control is given by: $T_e = KV_s^{\,2}$.

Hence determine the torque output of 950rpm, 6 pole, SO Hz, 3 phase, 415V 15kW output motor when line voltage is reduced to 350V **(8 marks)**

Question Four

a) Explain the principle applied:

(i) Cycloconversion
(ii) Field Oriented Control (FOC)
(iii) Direct Torque Control (DTC) **(3 marks)**

b) (i) With the aid of a sketch describe the function of several sections of 1 ϕ, 50H_z voltage source inverter VS1

(ii) Sketch the output, input DC, and triggering scheme for circuit in b(i) corresponding to Pulse Width Modulation (PWM) and 25Hz output. **(10 marks)**

c) A 3 phase square wave inverter is being supplied from a 415V source. The load voltage, current, frequency and power factor are 200V, 30A, 40Hz and 0.9 respectively. Determine:

(i) Voltage on DC side
(ii) DC component of current
(iii) The source side current (rms)
(iv) The firing angle **(7 marks)**

Question Five

a) Define the following terms for stepper motors:

(i) Step Angle
(ii) Resolution
(iii) Unipolar Drive **(3 marks)**

b) (i) With the aid of a construction and waveform show how 4 pole variable reluctance stepper functions with full stepping

(ii) Specify how mini step and half step operation modes are achieved for b(i) above. **(8 marks)**

c) A permanent magnet stepper motor has 6 poles each having 5 teeth and rotor having 50 teeth. The motor is coupled to the wheels of a robot with diameters of 7cm. The robot is required to cover a distance of 13.2m in 30 seconds. Determine:

(i) Step Angle
(ii) Resolution
(iii) Stepping Frequency required
(iv) Frequency of supply **(9 marks)**