Ref No: Ex/PG/EE/T/128A/2019

M.E. ELECTRICAL ENGINEERING - FIRST YEAR - SECOND SEMESTER

(1st / 2nd Semester/Repeat/Supplementary/Annual/Bi-Annual)

SUBJECT: - SMALL MACHINES, INCREMENTAL MOTION DEVICES AND ACTUATORS

Time: Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

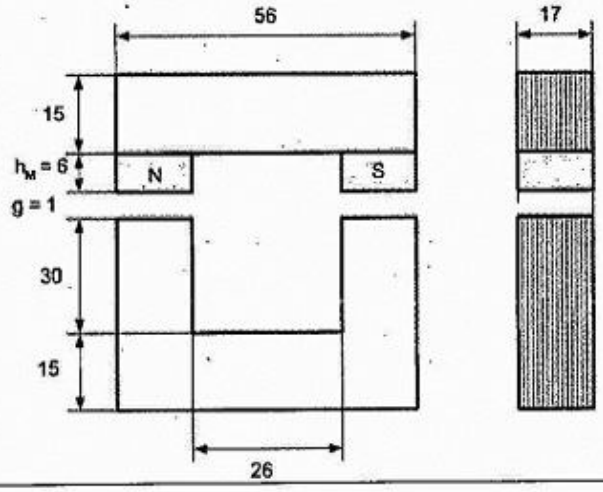
No. of Questions	PART II	Marks
	Answer any three Questions Two marks are for neat and systematic answers	
Q6.	a) Describe the basic constructional features of BLDC machines and enumerate its advantage/disadvantages over cage type induction machines for vehicular applications.	6+4
	b) Deduce the expression of induced EMF and torque in a BLDC machine and also show the sketch of emf waveform for any one phase.	6
Q7.	a) Using the model equations of a BLDC machine, develop its control block diagram and show that BLDC motor is inherently stable for speed control applications.	10
	b) Explain how speed and position feedback can be taken in a BLDC Drive system.	6
Q8.	a) Draw the schematic diagram of CSI fed BLDC Drive system and describe the operation of each blocks.	10
	b) Comment on the types of semiconductor switches that can be used in a BLDC drive system.	6
Q9.	a) With the help of the machine model equations, show the commutation torque ripple characteristics for a BLDC machine with speed. Draw neat sketches wherever necessary.	10
	b) Draw and explain how a three phase BLDC drive system can be designed using three semiconductor switches. Mention its relative merits and demerits.	6
Q.10	a) Explain how a Buck converter can be used for speed control of BLDC motor. Explain its relative merits and demerits compared to VSI fed drive system.	6+4
	b) Explain hoe current feedback can be taken for a BLDC drive system.	6

Master of Electrical Engineering, 1st Year 2nd Semester Examination, 2019

SUBJECT: SMALL MACHINES, INCREMENTAL MOTION DEVICES AND ACTUATORS (MC)

Time: Three Hours | Full Marks: 100 (50 for part I)

Use a separate Answer-Script for each part

	PART - II	
	Answer any three from the following. Question No. 2 carries the maximum marks.	
1. (i)	Can a DC motor be called an actuator? - explain	**4+4+8=16**
(ii)	What are the salient features of a DC servomotor?	
(iii)	Derive the mathematical model of a DC servomotor for position control.	
2. (i)	What is recoil permeability? Explain with proper diagram.	**4+5+9=18**
(ii)	How the demagnetization curve and the recoil lines are approximated?	
(iii)	With suitable assumptions determine the operating point for magnetization on the surface of a PM with armature.	
3.	A simple stationary magnetic circuit is shown in the following figure. There are two Vacomax sintered 225 HR Sm_2Co_{17} PMs with minimum value of B_r = 1.03 T, minimum value of H_c = 720 kA/m, temperature coefficients α_B= -0.030%/°C and α_H= -0.18%/°C. at 20 < υ_{PM}<120 °C. 	**16**

Use a separate Answer-Script for each part

	PART - II	
	The height of the PM is 6 mm and the air gap thickness g = 1 mm. the U-shaped and I-shaped ferromagnetic cores are made of a laminated electrotechnical steel. The width of the magnets and cores is 17 mm. Calculate the air gap magnetic flux density, air gap magnetic field strength, the useful energy of the PMs and normal attraction force per two poles at: (a) υ_{PM} = 20 °C and (b) υ_{PM} = 90 °C. The MVD in the laminated core, leakage and fringing magnetic flux can be neglected.	
4. i)	What is Carter's Coefficient?	3+5+8=16
ii)	Prove that in a PMDC machine if the PMs are longer than core the MVD across the air gap is $$\frac{\Phi_g}{\mu_0 \alpha_i \tau} \ln\left(\frac{L_M}{L_i}\right) \frac{k_C g}{L_M - L_i}$$	
(iii)	The symbols have their usual meaning.	
	Find the main dimensions of a PMDC commutator motor of cylindrical construction with a slotted rotor rated at: Pout = 50 W, V = 110 V, and n = 3500 rpm. The useful magnetic flux density cannot exceed 0.25T for the PM used. The efficiency at rated load should be a minimum of η =0 .6. The motor has to be designed for continuous duty. Assume air gap flux density to be 0.35 T and line current density to be 7500A/m.	
5.(i)	Determine the direct axis as well as quadrature axis armature reaction form factors for an inset type permanent magnet rotor structure in a PM synchronous motor.	8+8 =16
(ii)	Discuss the procedure for sizing and determining the main dimensions of a BLDC motor.	