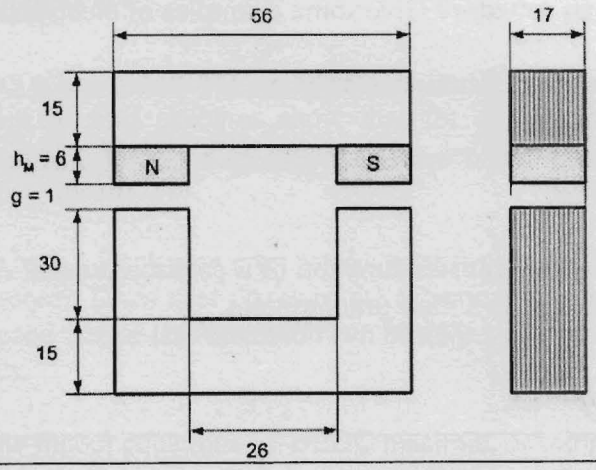
Master of Electrical Engineering, 1st Year 2nd Semester Examination, 2018

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

Time: Three Hours | Full Marks: 100 (60 for part II)

Use a separate Answer-Script for each part

	PART - I	
	Answer any three from the following.	
1. (i)	Define the terms: 'intrinsic demagnetization' and 'recoil magnetic permeability' of a permanent magnet.	**5+5+10=20**
(ii)	Prove that form factor of the demagnetization curve of a NdFeB magnet is almost ¼.	
(iii)	With suitable assumptions determine the operating point for magnetization on the surface of a PM without armature.	
2.	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. 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. 	**20**

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	PART - I	
3.(i)	What is Carter's Coefficient?	**4+6+10=20**
(ii)	Prove that in a PMDC machine if the PMs are longer than core the MVD across the air gap is $$\frac{\Phi_g}{\mu_0 \alpha_i \tau} \ln\left(\frac{L_M}{L_i}\right) \frac{k_C g}{L_M - L_i}$$ The symbols have their usual meaning.	
(iii)	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.	
4. 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.	**10+10 =20**
ii)	Discuss the procedure for sizing and determining the main dimensions of a BLDC motor.	
5.(i)	What is an actuator? Give some examples of electrical actuator.	**4+4+5+7=20**
(ii)	What are the differences between a DC motor and a DC servomotor?	
(iii)	Explain the basic operating principle and characteristics of an AC servomotor.	
(iv)	Show that the transfer function of a position control AC servo can be approximated as a ~~First~~ second order system.	

Ref No: Ex/PG/EE/T/128A/2018

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
(40 marks for this part)

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
	Answer any three Questions One mark is for neat and systematic answers	
Q6.	a) Compare the different features of BLDC motor over cage type induction machines for industrial applications.	6
	b) Deduce the expressions for induced EMF and torque of a BLDC machine. Show the sketches of phase EMF and phase current for a trapezoidal emf machine.	7
Q7.	a) With the help of suitable circuit diagram explain how BLDC motors can be driven with the help of three semiconductor switches. Also indicate the limitations of such drive system.	8
	b) Draw Explain the necessity of Hall sensors in a BLDC Drive system.	5
Q8.	a) Draw and explain the schematic diagram of CSI fed BLDC drive system.	5
	b) What is commutation torque ripple in a BLDC machine? With the help of neat sketches show that for a VSI fed BLDC machine, the commutation torque ripple can be made zero at a particular speed.	3+5
Q9.	Explain how a Buck converter can be used for speed control of BLDC motor. Draw neat sketch of the scheme and comment on How speed sensor less operation can be achieved for such schemes.	13
Q.10	Using the model equations of BLDC machine, develop the control block diagram and show the transfer function of the machine. Also show that the BLDC motor is inherently stable for speed control applications.	13