

**PARUL UNIVERSITY**  
**FACULTY OF ENGINEERING & TECHNOLOGY**  
**M.Tech., Winter 2017 - 18 Examination**

**Semester: 2**  
**Subject Code: 03203155**  
**Subject Name: Electrical Machine Modeling**

**Date: 12/01/2018**  
**Time: 02:00 pm to 04:30 pm**  
**Total Marks: 60**

**Instructions:**

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

**Q.1** A) Write transformation relationship between static and rotating reference frames for  $3\phi$  resistive Circuits. (05)

B) Explain the term “invariance of power” as applied to electrical machines. (05)

C) What is meant by reference frame theory? List commonly used reference frames. (05)

**Q.2** Answer the following questions. (Attempt any three) (Each five mark) (15)

A) What is vector rotator? Derive its equations. Explain its usefulness and significance.

B) Derive the general expression for force in terms of energy of a singly excited linear actuator.

C) For a doubly excited system, the inductances are approximated as follows, the coils are energized with direct currents  $I_1=0.7A$ ,  $I_2=0.8A$

$$L_1 = 11 + 3 \cos 2\theta \text{ H} \quad L_2 = 7 + 2 \cos 2\theta \text{ H} \quad M = 11 \cos \theta \text{ H}$$

Find the torque as a function of  $\theta$ , and its value when,  $\theta = -50^\circ$ .

D) Derive the transformations for currents between a rotating balanced z-phase ( $\alpha, \beta$ ) winding and a pseudo-stationary two- phase (d, q) winding. Assume equal turns on all coils.

**Q.3** A) Explain  $\lambda$ -i characteristics of magnetic system. Also derive expression for co-energy density. (07)  
 Assume that a  $\lambda$ -i relationship of magnetic circuit is linear.

B) Explain voltage equations in arbitrary reference frame variables for symmetrical induction Machines, with its equivalent circuits. (08)

**OR**

B) Derive torque equations of a three phase symmetrical induction machine in machine variables. (08)

**Q.4** A) Explain the dynamic performance during sudden change in load torque in symmetrical induction Machine. (07)

**OR**

A) Derive the voltage equations of permanent magnet brushless DC machine in rotor reference frame variables. (07)

B) Explain free acceleration characteristics of a symmetrical induction machine with torque-speed Characteristics during free acceleration. (08)