



Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)



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I SEMESTER M.TECH (MECHATRONICS ENGINEERING) END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: SENSORS AND ACTUATORS IN INDUSTRIAL AUTOMATION [MTE 501]

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ANY FIVE FULL the questions.
- ✤ Missing data may be suitably assumed.
- **1A.** Compare and contrast between induction motors and linear induction motors on the **3** following grounds:
 - i) Construction
 - ii) Working
 - iii) Applications
- 1B. Develop a pneumatic circuit for the sequence given below using the cascade method.
 4 The operation can start on the pressing of a START button.
 A+B+B-A-C+C-
- **1C.** Describe the cascade method of speed control of a three phase induction motor.

The figure below shows the torque-speed characteristics of a 3 \emptyset induction motor. Why does the motor operate at point 'b' rather than point a even though point 'a' is reached earlier when the machine is accelerating? T_L is a constant load torque applied to the motor.



2A. State and explain an application of a counter balance valve with appropriate **3** hydraulic circuit diagram.

- **2B.** A drive consisting of semiconductor converter fed DC motor runs according to the following duty cycle:
 - i) Acceleration from standstill to 1000 rpm in 10 sec at uniform acceleration.
 - ii) Running at 1000 rpm and 800 Nm torque for 8 sec.
 - iii) Braking from 1000 rpm to standstill in 10sec at uniform deceleration.
 - iv) Remains idle for 20 sec.

Determine torque ratings of the machine. Assume constant field current and J= 100 kg-m².

2C. Suggest suitable electrical sensors for the following applications and also explain its working:

Pressure measurement in the range of 0-5000 PSIG.

Pressure measurement in the range of 10⁻²mm to 10⁻⁸mm of mercury column.

- **3A.** Describe the operation of a single rack and pinion type rotary actuator with a schematic diagram. How can you double the torque output of the actuator?
- **3B.** What are rodless cylinders? Describe any two configurations of rodless cylinders **3** with their possible areas of applications.
- 3C. Differentiate between a switched reluctance and a synchronous reluctance motor. 4 How can a switched reluctance motor be used for forward motoring and regenerative braking?
- 4A. Develop an electropneumatic circuit to implement the sequence given below. The operation can start on the pressing of a START button. A+B+B-A-
- 4B. Describe the PLL method of speed control of a DC motor to achieve speed regulation 3 of upto 0.002 %
- 4C. A certain application requires continuous mixing of various gases. Hence a continuous metered flow of all the components has to be maintained. One of the components is hydrogen which accounts for only 1 % of the total mixture. The pipe diameter through which hydrogen flows is only 0.5 inch. Mention a suitable method to measure the flowrate of hydrogen. Explain its working.
- 5A. List the factors on which the choice of electric drives depends. How can you achieve 4 variable voltage variable frequency control for a three phase induction motor?
- 5B. Explain the working of one analog and one digital speed sensor that can be used for measurement of the speed of a motor shaft.
- 5C. Identify all the components used in the hydraulic circuit given in the next page and a explain the operation achieved.



- **6A.** What is slip power? Describe a speed control drive which efficiently utilizes the slip **3** power which would be otherwise wasted.
- **6B.** Design a closed loop position control loop for application in feed drives of machine **3** tools.
- **6C.** Explain why a DC series motor is more suited to deal with torque overloads than **4** other DC motors.

Justify why stator voltage control is an inefficient method of speed control of an induction motor and is generally restricted to fan-type loads.