

MANIPAL INSTITUTE OF TECHNOLOGY MANIPAL

A Constituent Institution of Manipal University

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

SUBJECT: SENSORS AND ACTUATORS IN INDUSTRIAL

AUTOMATION [MTE 5101]

REVISED CREDIT SYSTEM (24/11/2016)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ANY FIVE FULL questions.
- ✤ Missing data may be suitable assumed.
- 1A. i) In steel and iron industries, it is required to monitor temperatures and chemistry throughout the steel making process. Suggest and explain the working of a suitable sensor that can be used in the electric arc furnace process to accurately measure the temperature of steel.
 - ii) Explain a method of cold junction compensation of thermocouples
- 1B. Draw a comparative analysis between wound rotor synchronous and permanent 3 magnet synchronous motors on the following grounds:
 - a. Construction
 - b. Working
 - c. Applications
- 1C. Define slip power. Describe a speed control drive which efficiently utilizes the slip power which would be otherwise wasted.
- 2A. Explain why single phase induction motors are not self-starting. Elaborate on two 4 methods of starting a single phase induction motor.
- 2B. Explain why a DC series motor is more suited for torque overloads than other DC 3 motors.
- 2C. i) Describe the working of a BLDC motor.
 3 ii) Explain how a BLDC motor can be used as closed loop feed drive in CNC machine tools.
- **3A.** Answer the following with respect to induction motors:
 - i) Explain why is a 'soft start' required for a 3 phase induction motor. Also describe the method with appropriate circuit diagram
 - ii) Describe DC injection type of dynamic braking for a 3 phase induction motor.

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- **3B.** Suggest suitable electrical sensors for the following applications and also explain its working:
 - i) Pressure measurement in the range of 0-5000 PSIG.
 - ii) Pressure measurement in the range of 10^{-2} mm to 10^{-8} mm of mercury column.
- **3C.** The Fig. 3C 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.



- **4A.** For variable frequency control of induction motor, answer the following:
 - i) Explain why the (V/f) ratio maintained constant for speeds below base speed.
 - ii) Describe why the terminal voltage is maintained constant for speeds above base speed.
 - iii) With a schematic representation, explain inverter controlled variable voltage variable frequency induction motor drive when the supply available is AC.
- 4B. Ethylene used in petrochemical industries is stored in large storage vessels under pressure in liquid form. Suggest and explain the working of a suitable sensor which can be used to measure the level of liquid in the vessel.
- **4C.** Describe how a metal oxide semiconductor can be effectively utilized for sensing the presence as well as concentration of a particular gas in its vicinity.
- 5A. i) Explain four quadrant operation of electric motors.
 ii) With appropriate circuit diagram, describe two quadrant chopper control of separately excited DC motors.
- 5B. What are rodless cylinders? Describe any two configurations of rodless cylinders 3 with their possible areas of applications.
- 5C. Describe the working of a suitable sensor that can be used for the measurement of motor torque.
- 6A. i) Suggest and explain the working of a type of pneumatic cylinder that can be used for high velocity applications like punching and riveting.
 - ii) Develop a pneumatic circuit to control the extension and retraction of single acting cylinder with a 3/2 directional control valve.
- **6B.** Discuss a suitable method of speed control that can be employed for the use of 3phase induction motors in intermittent load applications like an overhead crane.
- **6C.** With a neat diagram, explain the working of a non-contact type of temperature **3** sensor.

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