M. Tech. In Intelligent Automation and Robotics, 2nd Year 2nd Semester, 2018

ADVANCED INSTRUMENTATION SYSTEMS

Time: 3 Hours

Full Marks: 100

Answer any **FIVE** questions.

1. a) What is the difference between a sensor and transducer? How incremental encoder differs from absolute encoder. Differentiate between span and range of a transducer.

   b)How a potentiometer can be used as a position sensor? A potentiometric position sensing device is designed for - 30 degree to + 80 degree rotation with available output voltage 1.2V to 2.5 volt. What will be range and span of the transducer?

   c) A mobile robot with 10 cm. wheel diameter fitted with an encoder having 16 count per revolution. What is the angular resolution of the encoder? Find the distance travelled by the robot for 1 count. How the direction of movement can be detected? Estimate the encoder counts for 1 meter of travel. 5 + 5 + 10

2. a)Describe the principle of working and construction of Piezo-electric poly vinylidene fluoride (PVDF) based tactile sensor. Describe necessary hardware interface to get suitable electric signal.

   b) What is tactile sensor array? How it helps to estimate the unknown shape of an object? What is *Cutaneous sense? How does it differ from* kinesthetic sense ? How is it possible to differentiate between a rectangular and a spherical object using tactile sensor array? 10 + 10

3 a) Explain the basic principle of CCD image sensor. What will be the mathematical interpretation of an image at particular point in a two dimensional plane?

   b) Describe the method of transferring a packet of charge through a potential wall? How digital image of an object is stored in a memory from an image sensor? 10 + 10

4. a) What is the basic principle of time of flight based range estimation? What are the potential sources of error for Time of Flight based Range estimation?

   b) What are the other techniques adapted for range measurement? Describe basic principle of phase shift and frequency modulation based range measurement technique. Establish the mathematical relation between distance versus measured phase shift and modulated frequency. 10 + 10

5. a) What is the difference between dead reckoning and odometry? How it is used for precise measurement of the location of a mobile robot? What are the major disadvantages of odometric measurement?

   b) What will be the restoring force of a spring under stress F(s)? Describe the working principle and construction of an accelerometer. What is the difference between an accelerometer and a gyroscope? Why acceleration measurement through an accelerometer is better than an odometric measurement in real time perspective?

   10 + 10

6. a) What is ultrasonic wave? How is it generated? Describe the method of getting distance of an object from a mobile robot using ultrasonic wave. What is cross talk? How is it possible to eliminate cross talk? If a robot has multiple sonar sensors, then how is it possible to prevent one sonar from not detecting an echo caused by another sonar sensor?

   b) What is Triangulation ranging? What is the difference between passive and active Triangulation ?

   15 + 5