

COURSE CODE: 21B1WCI831

MAX. MARKS: 35

COURSE NAME: DIGITAL TWIN – FUNDAMENTAL CONCEPTS TO APPLICATIONS IN
ADVANCED MANUFACTURING

COURSE CREDITS: 03

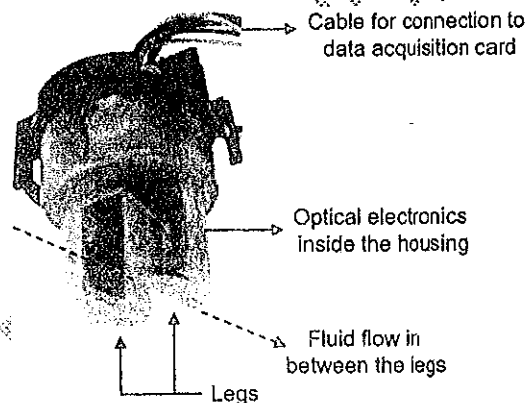
MAX. TIME: 2 Hrs

COURSE INSTRUCTOR: Prof. (Dr.) Vivek Kumar Sehgal

Note: All questions are compulsory. Carrying of mobile phone during examinations will be treated as case of unfair means.

1. (a) Explain the working of Turbidity Sensor

CO- 2 [2.5]



- (b) List the sensors for process and health monitoring in schematic format.

CO- 2 [2.5]

2. (a) Define piezoelectric effect and deduce its relation with force.

CO- 3 [2.5]

- (b) What is the difference between incremental and absolute encoder? Which type of encoder should be chosen for sensing a tool station?

CO- 4 [2.5]

3. For any manufacturing process, try operating it at two extreme conditions such that one will give a defect-free product and defective with the other. Engage two sensors relevant to the process. Implement signal processing techniques on the acquired signals via time and frequency domain techniques. Make a list of the statistical features and frequency information.?

CO- 4 [5]

4. What is Heisenberg uncertainty principle? Take a signal and apply STFT with different window sizes and visualize the difference in the corresponding outputs. CO- 5 [5]

5. If you want to apply machine vision in a high precision measurement application, then what are the two most important features for image acquisition? Name two types of illumination systems with one application each. What is F-number? How does the CCD sensor work in a CCD camera at the time of image acquisition? CO- 5 [5]

6. In a cold rolling technique, the rolled surface needs to be inspected by using machine vision system in real-time, when the speed of the surface is 5 m/s. The minimum width of the defect need to be imaged without motion blur is 1 mm. The camera needs to be placed in such a way that the angle between the planes of image and the rolled surface is zero. Considering the pixel pitch of image sensor as 7.5 μm , find out the maximum exposure times are required to acquire good images for defect detection by varying magnification as 0.2, 0.4 and 0.8. CO- 6 [5]

7. What is the output image $g(x, y)$ obtained from convolution of input image (a fragment of machined surface), $f(x, y)$ and the kernel $h(x, y)$, where: $f(x, y) =$

8	7	4	5	7
7	8	3	4	8
8	7	3	4	6
8	7	4	3	8
8	7	4	4	7

and, $h(x, y) = \begin{bmatrix} -2 & -2 & -2 \\ -2 & 16 & -2 \\ -2 & -2 & -2 \end{bmatrix}$

Name the type of kernel or filter, $h(x, y)$.

8	8	3	1	7
7	8	3	1	8
8	7	3	3	6
8	7	4	3	8
8	7	4	4	7

8	8	3	1	7
7	8	3	8	2
5	4	5	3	6
8	5	8	3	5
8	7	4	6	7

Mention the features selected for the classification.

CO- 6 [5]