

**FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI**  
**SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY**  
**DEPARTMENT OF MATERIALS AND METALLURGICAL ENGINEERING**  
**RAIN SEMESTER 2019/2020 EXAMINATIONS**

Friday, 02/07/21

**COURSE: MME 514 (Instrumentation & Meas. & Automation)**

**Time Allowed: 2½ hrs.**

**INSTRUCTION: Attempt any four (4) questions in all. Each question carries 17.5 marks.**

1. (a) Discuss temperature measurement using expansion of liquid method. [9.5 mks]  
 (b) With a neat sketch, identify the instrument for measuring temperature of water in the laboratory. Also list four other temperature measuring instruments. [8 mks]
2. (a) Compare and contrast Mechanical, Electrical and Electronic measuring instruments; give three examples in each classification. [9.5 mks]  
 (b) What are indication instruments? [3 mks]  
 (c) Complete the table below: [5 mks]

S/N	Quantity	Measuring instrument
1		Hygrometer
2	Gas flow rate	
3		Tachometer
4	Depth of treading in car tyre	
5		Dial indicator

3. (a) What is a venturimeter? [3 mks]  
 (b) Describe the converging, throat and diverging section of a venturimeter. [5 mks]  
 (c) Give an account of the working principle of venturimeter, stating the equations at the nozzle and throat section, the theoretical and actual discharge. Define every parameter in the equations. [9.5 mks]
4. (a) Distinguish between discrete and continuous data. [5 mks]  
 (b) The following strength (MPa) values for sintered clay discs of nominally 23mm diameter by 9mm thick were recorded by a postgraduate Student of MME Department:

4.305	4.613	5.535	5.843	6.150	6.458	6.765	7.073	7.380	7.995
4.613	5.225	5.535	5.843	6.150	6.458	7.073	7.380	7.688	8.610
4.613	5.225	5.535	6.150	6.458	6.765	7.073	7.380	7.688	8.918

Account for (i) the mean [5 mks] (ii) standard deviation, [5 mks] and (iii) coefficient of variation [2.5 mks] of the strength values.

5. (a) Use a suitable sketch with relevant equations to describe the U-tube manometer. [6.5 mks]  
 (b) A U-tube mercury manometer is used to measure the differential pressure in a water-filled pipe, and the difference in the mercury levels in the two legs is 65mm.  
 (i) If the density of glycerine is 1259kg/m<sup>3</sup> and that of mercury is 13590g/m<sup>3</sup>, what percentage error is introduced by neglecting the glycerine density in the limb? [7 mks].  
 (ii) What is the differential pressure being measured if the local value of g is 9.81m/s<sup>2</sup>? [4 mks]
6. (a) (i) Using block diagrams only, illustrate the dynamic performances of zero, first, and second order systems. [6 mks]  
 (ii) Use an appropriate sketch to discuss how the step response of a second order system could be influenced by the damping ratio. [5.5 mks]  
 (b) The dynamic performance of a piezo-electric accelerometer can be described by the following differential equation:  

$$\frac{d^2\theta_o}{dt^2} + 9.0 \times 10^3 \frac{d\theta_o}{dt} + 6.42 \times 10^{10} \theta_o = 17.0 \times 10^{10} \theta_i$$
 where,  $\theta_o$  is the output charge in pC and  $\theta_i$  is the input acceleration in ms<sup>-2</sup>. Determine the values of: (i) undamped natural frequency ( $\omega_n$ ), [3 mks] and (ii) damping ratio ( $\zeta$ ). [3 mks]