ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

SECOND SEMESTER EXAMINATIONS

2017/2018 ACADEMIC SESSION

COURSE: MEE 308 – Metrology (3 Units)

CLASS: 300 Level Mechanical Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer any 5 questions

HOD'S SIGNATURE

Date: July/August, 2018

Question 1

(a) Define Inspection and describe four salient points why it is important as a quality assurance method during manufacturing? **(5 marks)**

(b) What is the term Interchangeability and how does it influence the manufacturing process of a product? **(2 marks)**

(c) Describe Selective Assembly and explain how it helps resolve rejected components during manufacturing? **(2 marks)**

(d) Explain the wringing of slip gauges with the aid of clear diagrams **(3 marks)**

Question 2

(a) Differentiate between the terms Calibration and Standardization **(2 marks)**

(b) List Three major advantages of Calibration as related to manufacturing operation and Identify Six Standard procedures required to calibrate a named measuring instrument **(3 marks)**

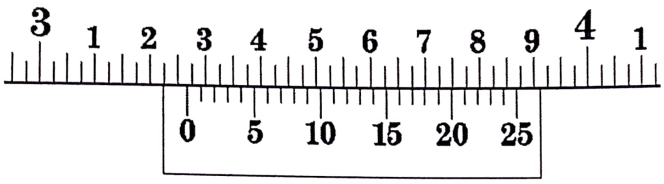
(c) Identify and discuss on the different types of measurement standards and differentiate this from the different basic types of material standards **(4 marks)**

(d) If the actual value of a steel rod diameter is 0.8597 mm and its approximate value is 0.85mm, Calculate the absolute, relative and percentile errors with their formulae **(3 marks)**

Question 3

(a) Differentiate between Two Point Measuring Contact Member approach and Three Point Measuring Contact Member approach citing an example of each **(2 marks)**

(b)



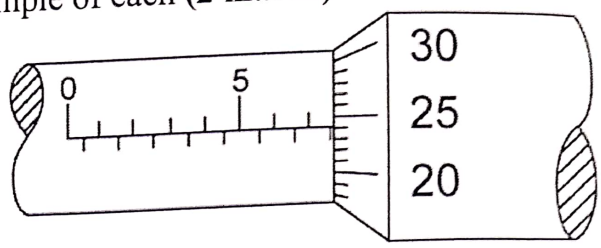


Fig. 3.1: Vernier Calliper Reading(mm). **Fig. 3.2:** Micrometre Screw Gauge Reading(mm).

Determine the Final readings on Figures 3.1 and 3.2, by first stating the formula for the least count, determining the least count, the main reading and the Vernier reading respectively. **(Note: There are 100 tick marks wrapped around the moving barrel of the micrometer in Fig. 3.2).** Discuss any geometric feature of a machined component that any of these instruments be used to measure **(5 marks)**

(c) Discuss the possible errors and precautions to be taken while measuring with a Vernier caliper/micrometer to minimize errors and briefly describe the function of a ratchet stop in the case of a micrometer **(2 marks)**

(d) Differentiate with the aid of diagrams where needed, between the following terms: **(3 marks)**

(i) Eccentricity and Concentricity

(ii) Alignment Test and Performance Test

(iii) Coaxiality and Cylindricity

Question 4

(a) Differentiate between the following terms **(4 marks)**:

(i) Tolerance and Tolerance Grade (ii) Basic Size and Actual Size

(iii) Fits and Allowance (iv) Zero Line and Deviation

(b) Explain the two systems of writing tolerances with suitable examples **(1 mark)**

(c) Determine the type of fit $55H_7f_8$ (Use Tables 1 and 2 together with Figure 4.1 and 4.2 to solve this question) **(7 marks)**

Table 1 *Geometric mean of diameter steps*

General Cases (mm)	0–3, 6–10, 18–30, 30–50, 50–80, 80–120, 120–180, 180–250, 250–315, 315–400, 400–500
Special Cases (mm)	10–14, 14–18, 18–24, 24–30, 30–40, 40–50, 50–65, 65–80, 80–100, 100–120, 120–140, 140–160, 160–180, 180–200, 200–225, 225–250, 250–280, 280–315, 315–355, 355–400, 400–450, 450–500

Question 5

(a) Explain with the aid of a sketch the four functional elements of a generalized measurement system and list out the three basic things for a measurement to be meaningful **(4 marks)**

(b) Discuss the typical output characteristics of a force measurement system with the aid of a well labelled diagram. Write short notes on Force and Load sensors and state the common technologies with which they work **(4 marks)**

(c). State and explain the operation of a typical load cell application with a neat sketch **(2 marks)**

(d). List and explain any four different device components normally involved in a torque sensor **(2 marks)**

Question 6

(a). Describe a basic Vibration Measurement system with the aid of a detailed sketch **(4 marks)**

(b) Discuss the principle of operation of an Orifice Meter for flow measurement with the aid of a well labelled sketch and state the advantages and its limitations. **(4 marks)**

(c). Differentiate between Absolute Pressure, Gauge Pressure and Differential Pressure of a Fluid **(2 marks)**

(d) Explain the following terms **(2 marks)**:

(i) Accelerometer (ii) Pressure Transducers

(iii) Differential Pressure Flowmeters (iv) A Dynamometer

Question 7

(a) Convert the following from one unit to the other and state the formula used **(3 marks)**:

(i) 20 degree Celsius to degree Rankine

(ii) Angular measurement of 270 degrees to radians

(iii) 9 Bars to kPa in Pressure measurement

(b) Explain what a strain gauge is and describe the principle with which it works with **(2 marks)**.

(c) Derive the relationship between resistance, R and strain to indicate the gauge factor, GF from ($R=\rho L/A$). Use this relationhip to calculate a change in resistance, if a 10 nanostrain is applied to a gauge with resistance, R of 120 ohms and GF of 2.0 **(5 marks)**

(d) Identify a mechanical analog pressure measuring instrument and briefly describe its working principle with a sketch. State the advantage and limitation **(2marks)**.

Table 2 *Tolerance grades IT5 to IT16*

Grade	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16
Tolerance	$7i$	$10i$	$16i$	$25i$	$40i$	$64i$	$100i$	$160i$	$250i$	$400i$	$640i$	$1000i$

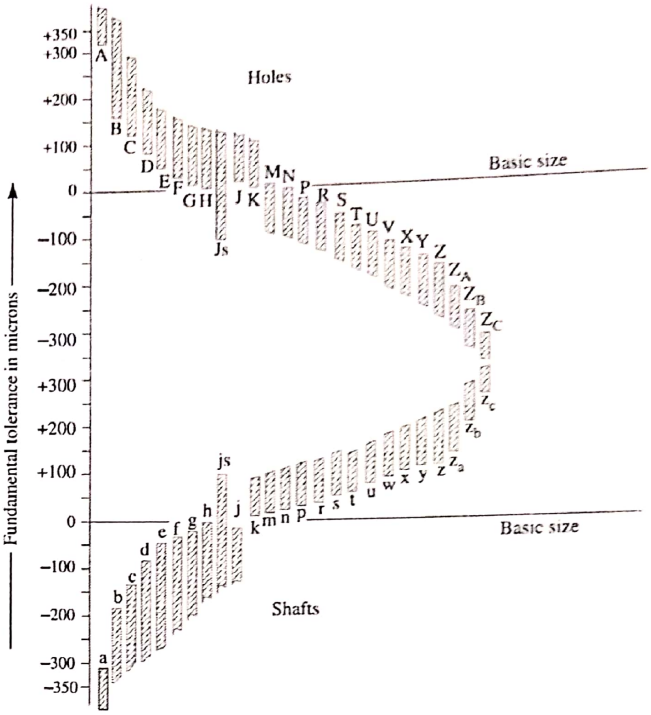


Fig. 4.1: Fundamental Deviation Series

Formulae for fundamental shaft deviations

Upper deviation (es)		*Lower deviation (ei)*	
Shaft designation	*In microns (for D in mm)*	*Shaft designation*	*In microns (for D in mm)*
a	$= -(265 + 1.3\,D)$ for $D \le 120$	*J* 5 to *j* 8	No formula
	$= -3.5\,D$ for $D > 120$	*k* 4 to *k* 7	$= +0.6\sqrt[3]{D}$
		k for grades ≤ 3 and ≥ 8	= 0
b	$= -(140 + 0.85\,D)$ for $D \le 160$	*m*	$= +(IT7 - IT6)$
	$= -1.8\,D$ for $D > 160$	*n*	$= +5\,(D)^{0.34}$
		p	$= +IT7 + 0$ to 5
c	$= -52\,(D)^{0.2}$ for $D \le 40$	*r*	= Geometric mean of values of *ei* for shaft *p* and *s*
	$= -(95 + 0.8\,D)$ for $D > 40$	*s*	$= +(IT8 + 1$ to $4)$ for $D \le 50$
			$= +(IT7 + 0.4\,D)$ for $D > 50$
d	$= -16\,(D)^{0.44}$	*t*	$= +(IT7 + 0.63\,D)$
e	$= -11\,(D)^{0.41}$	*u*	$= +(IT7 + D)$
f	$= -5.5\,(D)^{0.41}$	*v*	$= +(IT7 + 1.25\,D)$
		x	$= +(IT7 + 1.6\,D)$
g	$= -2.5\,(D)^{0.34}$	*y*	$= +(IT7 + 2\,D)$
		z	$= +(IT7 + 2.5\,D)$
h	= 0	*za*	$= +(IT8 + 3.15\,D)$
		zb	$= +(IT9 + 4\,D)$
		zc	$= +(IT10 + 5\,D)$