

**TECHNICAL UNIVERSITY OF MOMBASA**

**Faculty of Engineering and Technology**

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS FOR DEGREE IN BACHELOR OF SCIENCE IN  
MECHANICAL ENGINEERING

(BSME) Y3-S2

**EMG 2312: METROLOGY**

SPECIAL/SUPPLEMENTARY EXAMINATIONS

SERIES: MAY 2016

TIME: 2 HOURS

**INSTRUCTIONS:**

- ❖ You should have; Answer booklet,; Drawing instruments and Scientific calculator
- ❖ This paper consists of FIVE questions
- ❖ Attempt any THREE questions.

**This paper consists of THREE printed pages**

**QUESTION 1 (a) (i)** In taking measurements using the gear tooth vernier, derive the expression for gear tooth width and height setting (5 marks)

- (ii) A spur gear of 21 teeth and module 3 is to have its teeth measured using the gear tooth vernier. Evaluate the vernier width and height setting (5 marks)
- b) (i) For a spur gear using the gear tooth vernier derive the expression for gear tooth width and height setting for the constant chord method (5 marks)
- (ii) A spur gear of 22 teeth and module 4 is to have its teeth measured by the constant chord method. Determine the vernier width and height setting (5 marks)

**QUESTION 2**

Sample No	Measurements per sample Hundredths of one mm.				
1	622	623	622	624	623
2	623	624	625	623	624
3	624	623	625	623	624
4	624	624	625	625	626
5	624	624	625	625	626
6	624	625	626	624	625
7	625	625	626	626	625
8	626	625	625	625	627
9	626	626	627	626	626
10	626	627	627	628	626

The table shows samples of five taken at regular intervals from a process; 10 samples in all being taken. Plot the  $\bar{x}$  and w-charts.

### QUESTION3

- Describe the main requirements of the sine bar. *(5 marks)*
- Figure Q3b shows a gauge made in the geometrical profile shown. Determine the dimension h to the nearest 0.002mm. On such a gauge the dimension h is found to be correct; but each of the  $120^\circ$  angles is found to be four minutes of arc undersize. Determine the error introduced into the dimension l to the nearest 0.002mm. *(10 marks)*
- Figure Q3c shows a method used to determine large radius of curvature by measuring dimension h. If the dimension  $h=32.49\text{mm}$ , determine the radius of curvature R. *(5 marks)*

### QUESTION4

- With respect to testing of screw threads, derive the expression for:
  - Best wire size
  - Simple effective diameter. *(11 marks)*
- On testing a given thread of flank angle  $30^\circ$  and pitch 3mm, the wire available was of diameter 2mm and resulted in the dimension T under the wires of 49.132mm. Determine:
  - Best wire size
  - Simple effective diameter. *(4 marks)*
- Determine the diameter of a large bore measured with a pin gauge of length 450mm that rocks for 37mm. *(5 marks)*

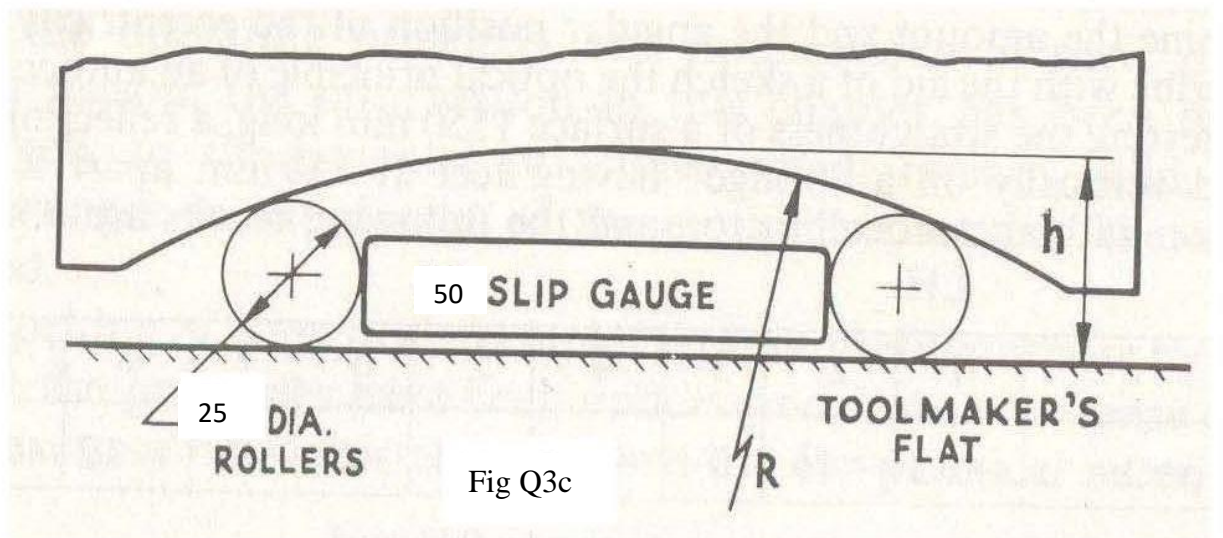
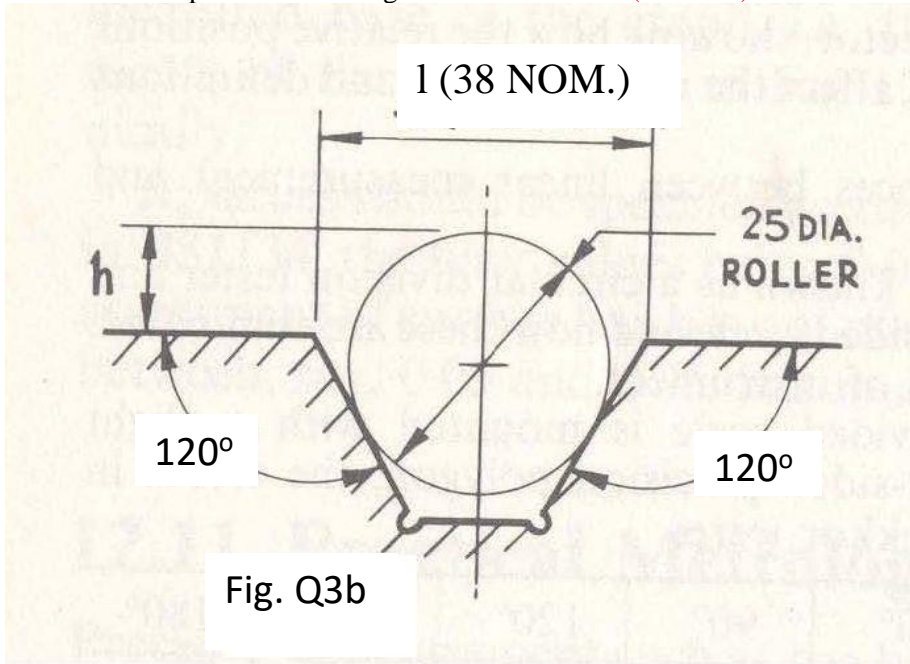
### QUESTION5

- Derive from first principles the  $D_{\max}$  and  $D_{\min}$  expressions for the taper plug gauge shown (Fig Q5)
  - On such a taper plug gauge the roller diameter is 10mm,  $h=53\text{mm}$ ,  $H=68\text{mm}$ ,  $M_2=49.27\text{mm}$ ,  $M_1=41.04\text{mm}$  and  $S=6\text{mm}$ . Determine:
    - Taper angle
    - $D_s$
    - $D_{\min}$
    - $D_{\max}$  *(14 marks)*
- The M87 set of slip gauges has the following pieces (Table Q5)

Range (mm)	Steps (mm)	No. of pieces
Wear blocks 2.5	-	2
1.001 to 1.009	0.001	9
1.01 to 1.49	0.01	49
0.5 to 9.5	0.5	19
10 to 90	10	9
1.0005	-	1

	Total	87
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Select the slips to build a length of 81.4565mm (6 marks)



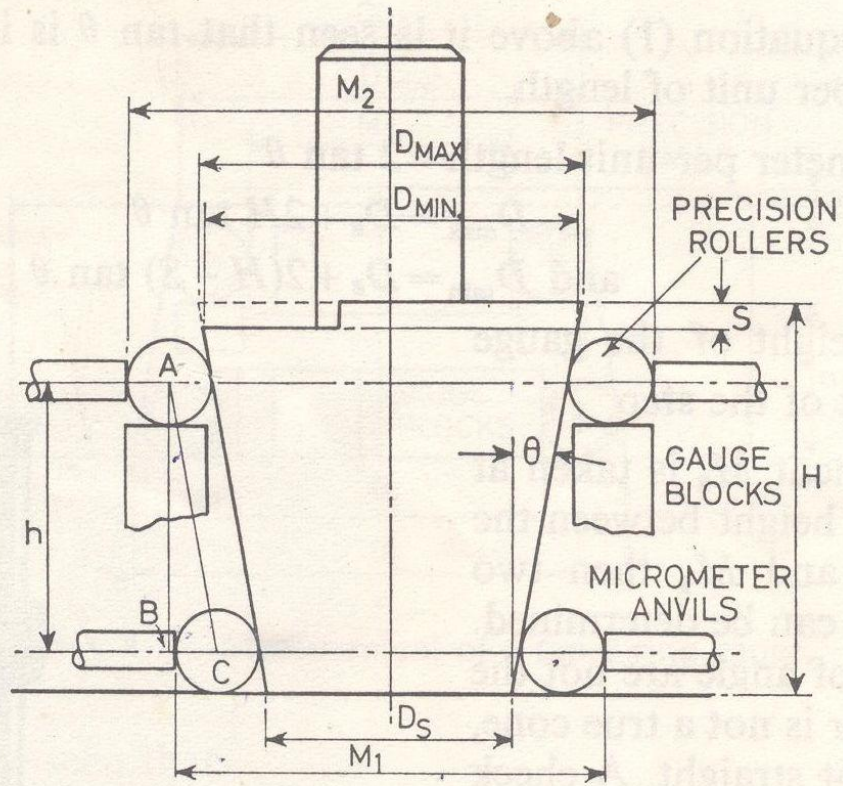


Fig Q5 Measurement of taper plug gauge.

### FACTORS USED IN $\bar{x}$ CHARTS

Sample size $n$	Warning factor $A^{1}_{0.025}$	Action factor $A^{1}_{0.001}$
2	1.229	1.937
3	0.668	1.054
4	0.476	0.750
5	0.377	0.594
6	0.316	0.498
7	0.274	0.432
8	0.244	0.384
9	0.220	0.347
10	0.202	0.317

### FACTORS USED IN $w$ CHARTS

Sample size $n$	Upper action factor $D^{1}_{0.999}$	Upper warning factor $D^{1}_{0.975}$	Lower warning factor $D^{1}_{0.025}$	Lower action factor $D^{1}_{0.001}$
2	4.12	2.81	0.04	0.00
3	2.98	2.17	0.18	0.04
4	2.57	1.93	0.29	0.10
5	2.34	1.81	0.37	0.16
6	2.21	1.72	0.42	0.21
7	2.11	1.66	0.46	0.26
8	2.04	1.62	0.50	0.29
9	1.99	1.58	0.52	0.32
10	1.93	1.56	0.54	0.35

FIG Q2