

**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-S1

**EMG 2312: METROLOGY**

END OF SEMESTER 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 28 teeth and module 5 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 28 teeth and module 5 is to have its teeth measured by the constant chord method. Determine the vernier width and height setting (5 marks)

**QUESTION 2** The following table gives the sample values of 20 samples of 4 items each. Plot the  $\bar{X}$  and  $\bar{W}$  -charts. Is the process in control? (20 marks)

Sample number				
1	1.16	1.25	0.66	0.56
2	0.84	0.82	0.92	0.6
3	0.97	0.94	0.99	0.9
4	1.0	0.94	1.5	1.18
5	0.750	0.97	0.47	0.73
6	0.92	0.6	0.82	1.14
7	1.17	1.0	0.85	0.36

8	0.68	0.93	0.89	1.13
9	1.0	0.91	0.6	0.68
10	0.97	0.87	0.71	0.89
11	0.73	0.66	0.79	0.59
12	0.82	0.77	0.67	0.70
13	0.9	1.25	1.00	0.81
14	0.57	0.62	0.61	0.69
15	0.61	1.02	1.45	0.93
16	0.81	1.00	1.25	0.9
17	0.71	0.94	0.87	0.84
18	0.97	1.06	1.10	0.89
19	1.12	0.73	0.62	0.78
20	0.68	0.61	1.00	1.11

### 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 140° angles is found to be six minutes of arc oversize. 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=28mm, 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 29° and pitch 3mm, the wire available was of diameter 2mm and resulted in the dimension T under the wires of 48.753mm. Determine:
  - Best wire size
  - Simple effective diameter. *(4 marks)*
- Determine the diameter of a large bore measured with a pin gauge of length 500mm that rocks for 60mm. *(5 marks)*

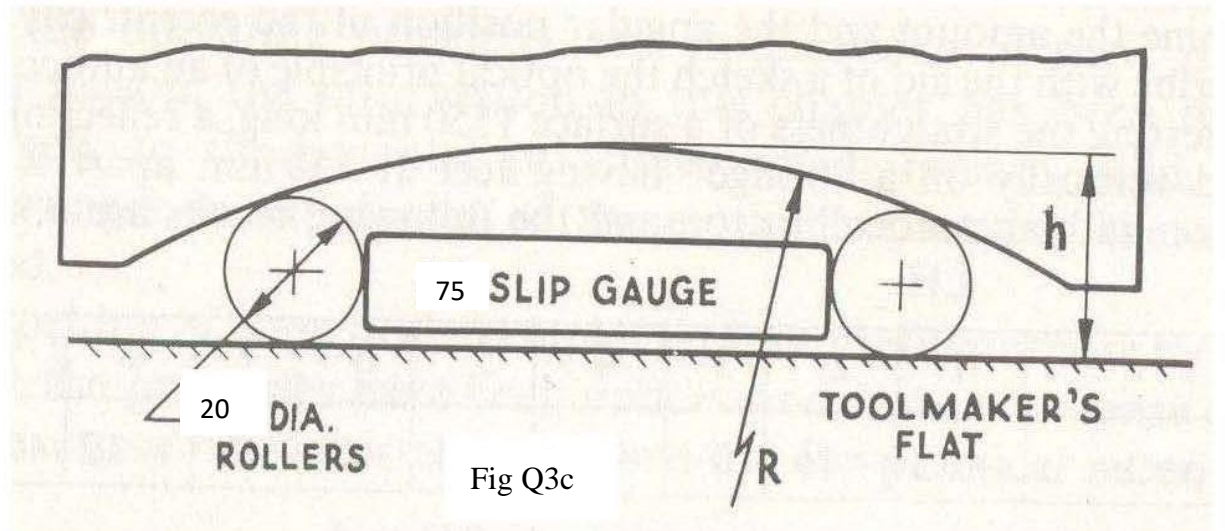
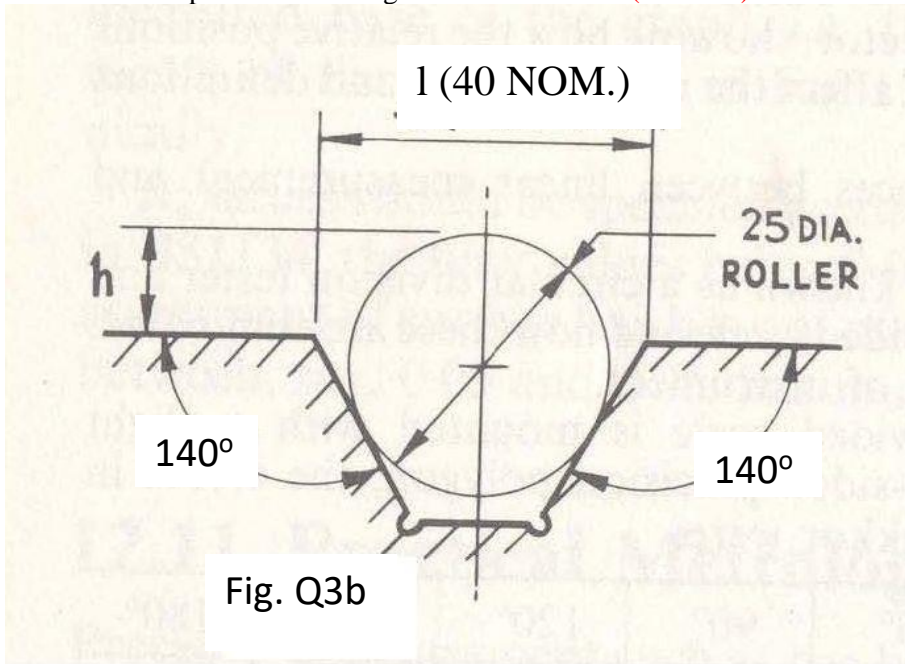
### QUESTION5

- Derive from first principles the D<sub>max</sub> and D<sub>min</sub> expressions for the taper plug gauge shown (Fig Q5)
  - On such a taper plug gauge the roller diameter is 9mm, h=55mm, H=66mm, M<sub>2</sub>=48.37mm, M<sub>1</sub>=40.48mm and S=5mm. Determine:
    - Taper angle
    - D<sub>s</sub>
    - D<sub>min</sub>
    - D<sub>max</sub> *(14 marks)*
- The M87 set of slip gauges has the following pieces (Table Q5)

Range (mm)	Steps (mm)	No. of pieces
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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

Select the slips to build a length of 87.3215mm (6 marks)



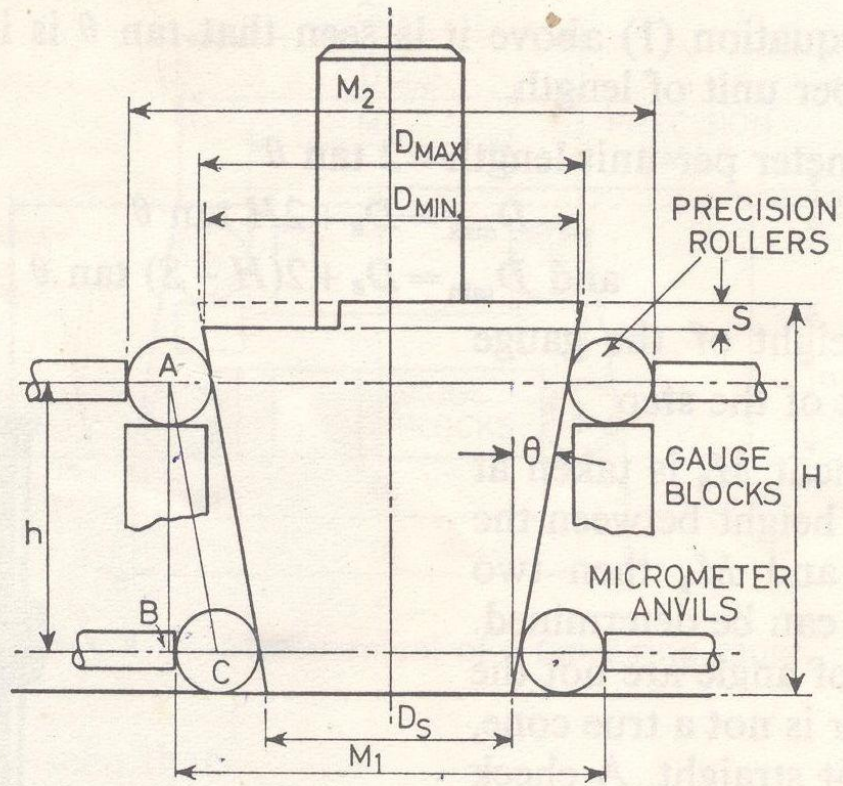


Fig Q5 Measurement of taper plug gauge.

### 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