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

<u>INSTRUCTIONS:</u>

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

<u>This paper consists of THREE printed pages</u>

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

a) Describe the main requirements of the sine bar. *(5 marks)*
b) 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° 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)*
c) Figure Q3c shows a method used to determine large radius of curvature by measuring dimension h. If the dimension h=32.49mm, determine the radius of curvature R. *(5 marks)*

QUESTION4

a) With respect to testing of screw threads, derive the expression for:
    (i) Best wire size
    (ii) Simple effective diameter. (11 marks)
b) On testing a given thread of flank angle 30° and pitch 3mm, the wire available was of diameter 2mm and resulted in the dimension T under the wires of 49.132mm. Determine:
    i) Best wire size
    ii) Simple effective diameter. (4 marks)
c) Determine the diameter of a large bore measured with a pin gauge of length 450mm that rocks for 37mm. (5 marks)
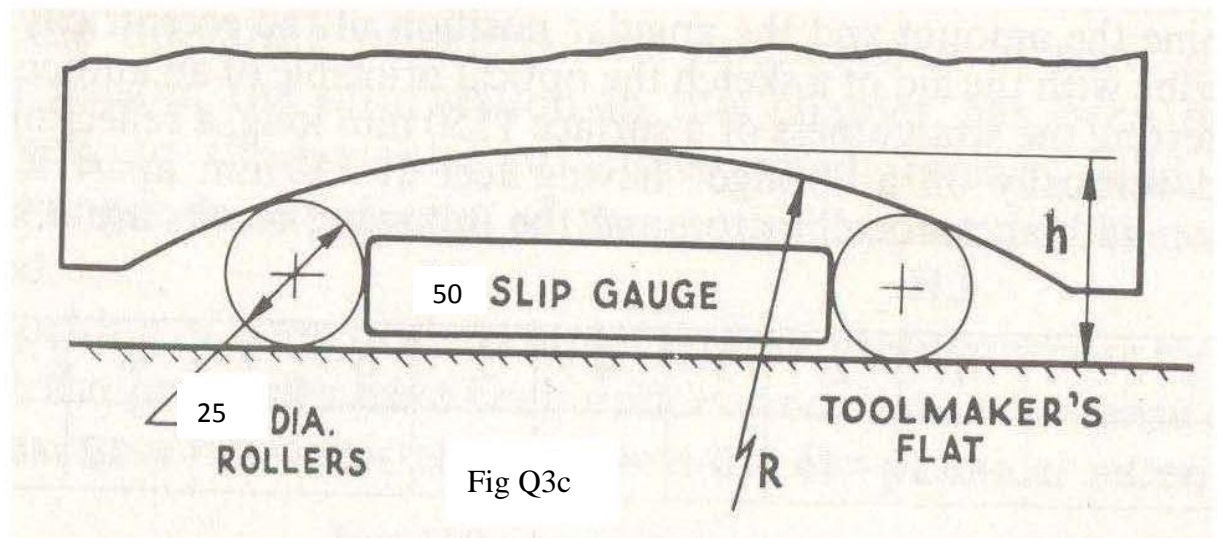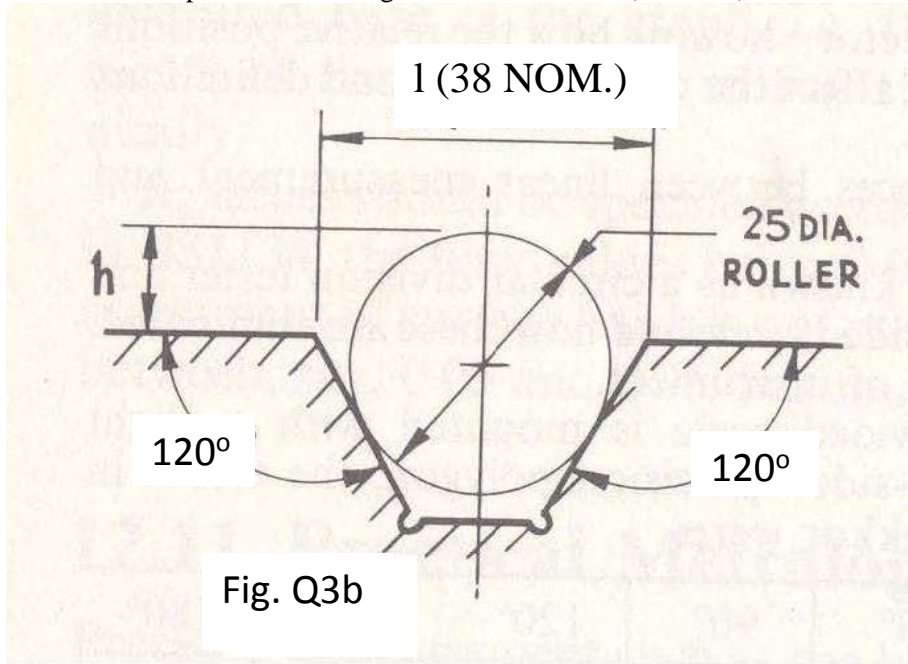
QUESTION5
a) (i) Derive from first principles the Dmax and Dmin expressions for the taper plug gauge shown (Fig Q5)
   (ii)On such a taper plug gauge the roller diameter is 10mm, h=53mm, H=68mm, M_2=49.27mm, M_1=41.04mm and S=6mm. Determine:
       (I)   Taper angle
       (II) D_s
       (III) D_{min}
       (IV) D_{max} (14 marks)
b) 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

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

l (38 NOM.)

25 DIA.
ROLLER

h

120º   120º

Fig. Q3b

50 SLIP GAUGE

25 DIA.
ROLLERS

h

TOOLMAKER'S
FLAT

R

Fig Q3c

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