



**PROGRAM** : NATIONAL DIPLOMA  
*INDUSTRIAL ENGINEERING TECHNOLOGY*

**SUBJECT** : **ENGINEERING WORK STUDY II**

**CODE** : **TIV 231**

**DATE** : MID-YEAR EXAMINATIONS 2016  
03 JUNE 2016

**DURATION** : 8:30-11:30

**WEIGHT** : 40 : 60

**TOTAL MARKS** : 100

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**EXAMINER** : MRS R. STEENKAMP

**MODERATOR** : MR G. DE CLERCQ

**NUMBER OF PAGES** : 4 PAGES  
ANNEXURES 4 PAGES

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**REQUIREMENTS** : STUDENTS MAY USE CALCULATORS  
GRAPH PAPER IS REQUIRED

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**INSTRUCTIONS TO CANDIDATES:**

1. PLEASE ANSWER ALL THE QUESTIONS.
2. SHOW ALL THE CALCULATIONS.
3. FOR ANY DATA NOT PROVIDED; STUDENTS ARE EXPECTED TO MAKE REALISTIC ASSUMPTIONS

**QUESTION 1**

- 1.1. Name three general rules that help with workplace layout from an ergonomic point of view. (3)
  - 1.2. When an operator is working in a standing position name three factors to consider from an ergonomic point of view. (3)
  - 1.3. What is facilitation? (2)
  - 1.4. What is plant and machine control? (2)
  - 1.5. What is the typical hierarchy of document? (4)
  - 1.6. What is the purpose of an X-chart? (2)
- [16]**

**QUESTION 2**

An operator produces 275 pieces per day, the standard time for an operation is 1.6 min per piece. The operator has an 8.5 hour working day; he does however have 25 minutes waiting time during the day. The operator has a base rate of R175 per hour. Calculate

- 2.1 Standard hours earned
- 2.2 Operators efficiency
- 2.3 Direct labour cost per piece at this efficiency
- 2.4 Labour utilisation
- 2.5 Labour productivity

**[10]****QUESTION 3**

- 3.1. Do a PTS analyses for the following process and what is the total tmu?  
Get a handful of washers from a container jumbled together and put them onto 3 bolts located 12cm apart. (9)
  - 3.2. A worker slides a ruler (20cm) and pushes it 14 cm to measure two points that are 20 cm apart process stops at measurement. (7)
- [16]**

**QUESTION 4**

The company has established base rate to produce polymer tubes of different diameter and length. Operators are experienced in this process.

	Diameter			
	10mm	20mm	30mm	40mm
Length	Sec	Sec	Sec	Sec
1m	15	25	35	40

<b>1.5m</b>	20	30	40	45
<b>2m</b>	25	35	45	50
<b>2.5m</b>	30	40	50	55

Formulas

$$T = a_1 + (a_2 - a_1)f$$

T = base time x factor

- 4.1 Determine by calculation the time for producing a tube that has a diameter of 25mm and a length of 1.75m
- 4.2 Determine by graphical factor comparison the time to produce a tube that has a diameter of 15mm and a length of 2.25m. Use a length of 2m to determine the factor curve.

[15]

### QUESTION 5

Draw a cause and effect diagram of all the reasons why runs are scored in cricket. A study was completed and the following was found the number of runs scored is influenced by the batting position, the bowling style as well as the batting style. The fitness and amount of practice before the match also has an influence on the number of runs scored. Different pitches tend to influence either high or low scores. The outfield conditions also influence the game and the number of scores. Outside factors that play a role are things like the weather and the venue. The batting partners also seem to affect the score. For the players their gear also influences how well they play and score; things such as the type of bat, the type of ball and the type of protective gear that they wear.

[12]

### QUESTION 6

The following was observed of a office worker. The office worker spent up to 8 hours sitting at the computer per day, with few breaks. The office worker had heavy usage of the mouse, which was positioned away from the keyboard on the right hand side (RHS). The telephone was used frequently. The office worker also tended to cradle handset into the neck to free both hands for computer use. The worker had a height adjustable chair and a fixed height desk. Seat height was particularly low, requiring User to rest forearms on the desktop when keying. Frequently used items (e.g. cell phone, stationery) were positioned at the rear of the desk.

Name six things that you would recommend from an ergonomic point of view to improve this process.

[6]

### QUESTION 7

Draw a single column process chart of the following process

Receive raw resin and other components at the store, visual inspection is done of components. All defective components are segregated and returned. All components that are acceptable are booked into the store. The resin is taken from the store to the lab where resin verification is done. The operator waits for the verification to be completed and then takes the resin to his work station. At the workstation the operator sets up his machine for production.

[12]

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### **QUESTION 8**

Wow-manufacturing has approached you as the industrial engineer to determine which of the following incentive schemes will be best for them they want to motivate workers but are constrained by the budget. A group of employees work a 40-hour working week, a worker needs to complete a 1200 pieces per week. The hourly pay is R90. A worker completes the work in 36 hours. Calculate the bonus and total earnings for the following schemes

- |      |                                           |     |
|------|-------------------------------------------|-----|
| 8.1. | Guaranteed scheme                         | (3) |
| 8.2  | Halsey Premium bonus scheme               | (3) |
| 8.3. | Halsey- Weir                              | (3) |
| 8.4. | Rowan Scheme                              | (3) |
| 8.5  | Which Scheme would you recommend and why? | (1) |

[13]

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**TOTAL : 100**  
**Full marks 100**

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Table 24. Methods-Time Measurement application data in tmu (Based metric weights and measures)

I. REACH — R							
Distance (cm)	Time (tmu)				Hand in motion		Case and description
	A	B	C or D	E	A	B	
2 or less	2.0	2.0	2.0	2.0	1.6	1.6	A. Reach to object in fixed location; or to object in other hand or on which other hand rests
4	3.4	3.4	5.1	3.2	3.0	2.4	
6	4.5	4.5	6.5	4.4	3.9	3.1	
8	5.5	5.5	7.5	5.5	4.6	3.7	
10	6.1	6.3	8.4	6.8	4.9	4.3	
12	6.4	7.4	9.1	7.3	5.2	4.8	B. Reach to single object in location which may vary slightly from cycle to cycle
14	6.8	8.2	9.7	7.8	5.5	5.4	
16	7.1	8.8	10.3	8.2	5.8	5.9	
18	7.5	9.4	10.8	8.7	6.1	6.5	
20	7.8	10.0	11.4	9.2	6.5	7.1	
22	8.1	10.5	11.9	9.7	6.8	7.7	C. Reach to object jumbled with other objects in a group so that search and select occur
24	8.5	11.1	12.5	10.2	7.1	8.2	
26	8.8	11.7	13.0	10.7	7.4	8.8	
28	9.2	12.2	13.6	11.2	7.7	9.4	
30	9.5	12.8	14.1	11.7	8.0	9.9	
35	10.4	14.2	15.5	12.9	8.8	11.4	D. Reach to a very small object or where accurate grasp is required
40	11.3	15.6	16.8	14.1	9.6	12.8	
45	12.1	17.0	18.2	15.3	10.4	14.2	
50	13.0	18.4	19.6	16.5	11.2	15.7	
55	13.9	19.8	20.9	17.8	12.0	17.1	
60	14.7	21.2	22.3	19.0	12.8	18.5	E. Reach to indefinite location to get hand in position for body balance or next motion or out of way
65	15.6	22.6	23.6	20.2	13.5	19.9	
70	16.5	24.1	25.0	21.4	14.3	21.4	
75	17.3	25.5	26.4	22.6	15.1	22.8	
80	18.2	26.9	27.7	23.9	15.9	24.2	

#### INTRODUCTION TO WORK STUDY

##### IV. GRASP — G

Case	Time (sec)	Description
1A	2.0	Pick up grasp — small, medium or large object by itself, easily grasped
1B	3.5	Very small object or object lying close against a flat surface
1C1	7.3	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter larger than 12 mm
1C2	8.7	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter 6 to 12 mm
1C3	10.8	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter less than 6 mm
2	5.6	Regrasp
3	5.6	Transfer grasp
4A	7.3	Object jumbled with other objects so search and select occur. Larger than 25 x 25 x 25 mm
4B	9.1	Object jumbled with other objects so search and select occur. 6 x 6 x 3 mm to 25 x 25 x 25 mm
4C	12.9	Object jumbled with other objects so search and select occur. Smaller than 6 x 6 x 3 mm
5	0	Contact, sliding or hook grasp

##### V. POSITION — P

Class of fit	Symmetry	Easy to handle	Difficult to handle
1. Loose — No pressure required	S SS NS	5.6 9.1 10.8	11.2 14.7 16.0
2. Close — Light pressure required	S SS NS	16.2 19.7 21.0	21.8 25.3 26.6
3. Exact — Heavy pressure required	S SS NS	43.0 46.5 47.8	48.6 52.1 53.4

\*Distance allowed to engage — max. 25 mm.

##### VI. RELEASE — R1

Case	Time (sec)	Description
1	2.0	Normal release performed by opening fingers as independent motion
2	0	Contact release

##### VII. DISENGAGE — D

Class of fit	Easy to handle	Difficult to handle
1. Loose — Very slight effort, blends with subsequent move	4.0	5.7
2. Close — Normal effort, slight recoil	7.5	11.8
3. Tight — Considerable effort, hand recoils markedly	22.9	34.7

##### VIII. EYE TRAVEL and EYE FOCUS — ET and EF

Eye travel time =  $15.2 \times \frac{T}{D}$  mm, with a maximum value of 20 mm

where  $T$  = the distance between points from and to which the eye travels,  
 $D$  = the perpendicular distance from the eye to the line of travel  $T$ .  
 Eye focus time = 7.3 mm.

# INTRODUCTION TO WORK STUDY

## IX. BODY, LEG AND FOOT MOTIONS

Description	Symbol	Distance	Time (sec)
Foot motion — Hinged at ankle With heavy pressure	FM FMP	Up to 10 cm	8.5 19.1
Leg or foreleg motion	LMT	Up to 15 cm Each extra cm	7.1 0.5
Sidestep — Case 1 — Complete when leading leg contacts floor	SS-C1	Less than 30 cm 30 cm Each extra cm	Use REACH or MOVE time 17.0 0.2
Case 2 — Lagging leg must contact floor before next motion can be made	SS-C2	Up to 30 cm Each extra cm	34.1 0.4
Bend, stoop, or kneel on one knee Arise	B.S KOK AR, AS, AKOK		29.0 31.9 69.4
Kneel on floor — both knees Arise	KBK AKBK		76.7
Sit	SIT		34.7
Stand from sitting position Turn body 45 to 90 degrees	STD		43.3
Case 1 — Complete when leading leg contacts floor	TBC1		18.2
Case 2 — Lagging leg must contact floor before next motion can be made	TBC2		37.2
Walk	WM	Per metre	17.4
Walk — obstructed	W-P W-PO	Per pace Per pace	15.0 17.0

## PREDETERMINED TIME STANDARDS

### X. SIMULTANEOUS MOTIONS

REACH	MOVE	GRASP	POSITION	DISCHARGE	
AE	C	G1A	P1S	D1E	REACH
B	A, Bm	G2	P1S, P2S	D1E, D1D	
C		G3	P1S, P2S, P2NS	D1D	
D	W, O, W, O, W, O	G4	P1S, P2S, P2NS	D1D	
E		G5	P1S, P2S, P2NS	D1D	
F		G6	P1S, P2S, P2NS	D1D	
G		G7	P1S, P2S, P2NS	D1D	
H		G8	P1S, P2S, P2NS	D1D	
I		G9	P1S, P2S, P2NS	D1D	
J		G10	P1S, P2S, P2NS	D1D	
K		G11	P1S, P2S, P2NS	D1D	
L		G12	P1S, P2S, P2NS	D1D	
M		G13	P1S, P2S, P2NS	D1D	
N		G14	P1S, P2S, P2NS	D1D	
O		G15	P1S, P2S, P2NS	D1D	
P		G16	P1S, P2S, P2NS	D1D	
Q		G17	P1S, P2S, P2NS	D1D	
R		G18	P1S, P2S, P2NS	D1D	
S		G19	P1S, P2S, P2NS	D1D	
T		G20	P1S, P2S, P2NS	D1D	
U		G21	P1S, P2S, P2NS	D1D	
V		G22	P1S, P2S, P2NS	D1D	
W		G23	P1S, P2S, P2NS	D1D	
X		G24	P1S, P2S, P2NS	D1D	
Y		G25	P1S, P2S, P2NS	D1D	
Z		G26	P1S, P2S, P2NS	D1D	
AA		G27	P1S, P2S, P2NS	D1D	
AB		G28	P1S, P2S, P2NS	D1D	
AC		G29	P1S, P2S, P2NS	D1D	
AD		G30	P1S, P2S, P2NS	D1D	
AE		G31	P1S, P2S, P2NS	D1D	
AF		G32	P1S, P2S, P2NS	D1D	
AG		G33	P1S, P2S, P2NS	D1D	
AH		G34	P1S, P2S, P2NS	D1D	
AI		G35	P1S, P2S, P2NS	D1D	
AJ		G36	P1S, P2S, P2NS	D1D	
AK		G37	P1S, P2S, P2NS	D1D	
AL		G38	P1S, P2S, P2NS	D1D	
AM		G39	P1S, P2S, P2NS	D1D	
AN		G40	P1S, P2S, P2NS	D1D	
AO		G41	P1S, P2S, P2NS	D1D	
AP		G42	P1S, P2S, P2NS	D1D	
AQ		G43	P1S, P2S, P2NS	D1D	
AR		G44	P1S, P2S, P2NS	D1D	
AS		G45	P1S, P2S, P2NS	D1D	
AT		G46	P1S, P2S, P2NS	D1D	
AU		G47	P1S, P2S, P2NS	D1D	
AV		G48	P1S, P2S, P2NS	D1D	
AW		G49	P1S, P2S, P2NS	D1D	
AX		G50	P1S, P2S, P2NS	D1D	
AY		G51	P1S, P2S, P2NS	D1D	
AZ		G52	P1S, P2S, P2NS	D1D	
BA		G53	P1S, P2S, P2NS	D1D	
BB		G54	P1S, P2S, P2NS	D1D	
BC		G55	P1S, P2S, P2NS	D1D	
BD		G56	P1S, P2S, P2NS	D1D	
BE		G57	P1S, P2S, P2NS	D1D	
BF		G58	P1S, P2S, P2NS	D1D	
BG		G59	P1S, P2S, P2NS	D1D	
BH		G60	P1S, P2S, P2NS	D1D	
BI		G61	P1S, P2S, P2NS	D1D	
BJ		G62	P1S, P2S, P2NS	D1D	
BK		G63	P1S, P2S, P2NS	D1D	
BL		G64	P1S, P2S, P2NS	D1D	
BM		G65	P1S, P2S, P2NS	D1D	
BN		G66	P1S, P2S, P2NS	D1D	
BO		G67	P1S, P2S, P2NS	D1D	
BP		G68	P1S, P2S, P2NS	D1D	
BQ		G69	P1S, P2S, P2NS	D1D	
BR		G70	P1S, P2S, P2NS	D1D	
BS		G71	P1S, P2S, P2NS	D1D	
BT		G72	P1S, P2S, P2NS	D1D	
BU		G73	P1S, P2S, P2NS	D1D	
BV		G74	P1S, P2S, P2NS	D1D	
BW		G75	P1S, P2S, P2NS	D1D	
BX		G76	P1S, P2S, P2NS	D1D	
BY		G77	P1S, P2S, P2NS	D1D	
BZ		G78	P1S, P2S, P2NS	D1D	
CA		G79	P1S, P2S, P2NS	D1D	
CB		G80	P1S, P2S, P2NS	D1D	
CC		G81	P1S, P2S, P2NS	D1D	
CD		G82	P1S, P2S, P2NS	D1D	
CE		G83	P1S, P2S, P2NS	D1D	
CF		G84	P1S, P2S, P2NS	D1D	
CG		G85	P1S, P2S, P2NS	D1D	
CH		G86	P1S, P2S, P2NS	D1D	
CI		G87	P1S, P2S, P2NS	D1D	
CJ		G88	P1S, P2S, P2NS	D1D	
CK		G89	P1S, P2S, P2NS	D1D	
CL		G90	P1S, P2S, P2NS	D1D	
CM		G91	P1S, P2S, P2NS	D1D	
CN		G92	P1S, P2S, P2NS	D1D	
CO		G93	P1S, P2S, P2NS	D1D	
CP		G94	P1S, P2S, P2NS	D1D	
CQ		G95	P1S, P2S, P2NS	D1D	
CR		G96	P1S, P2S, P2NS	D1D	
CS		G97	P1S, P2S, P2NS	D1D	
CT		G98	P1S, P2S, P2NS	D1D	
CU		G99	P1S, P2S, P2NS	D1D	
CV		G100	P1S, P2S, P2NS	D1D	
CW		G101	P1S, P2S, P2NS	D1D	
CX		G102	P1S, P2S, P2NS	D1D	
CY		G103	P1S, P2S, P2NS	D1D	
CZ		G104	P1S, P2S, P2NS	D1D	
DA		G105	P1S, P2S, P2NS	D1D	
DB		G106	P1S, P2S, P2NS	D1D	
DC		G107	P1S, P2S, P2NS	D1D	
DD		G108	P1S, P2S, P2NS	D1D	
DE		G109	P1S, P2S, P2NS	D1D	
DF		G110	P1S, P2S, P2NS	D1D	
DG		G111	P1S, P2S, P2NS	D1D	
DH		G112	P1S, P2S, P2NS	D1D	
DI		G113	P1S, P2S, P2NS	D1D	
DJ		G114	P1S, P2S, P2NS	D1D	
DK		G115	P1S, P2S, P2NS	D1D	
DL		G116	P1S, P2S, P2NS	D1D	
DM		G117	P1S, P2S, P2NS	D1D	
DN		G118	P1S, P2S, P2NS	D1D	
DO		G119	P1S, P2S, P2NS	D1D	
DP		G120	P1S, P2S, P2NS	D1D	
DQ		G121	P1S, P2S, P2NS	D1D	
DR		G122	P1S, P2S, P2NS	D1D	
DS		G123	P1S, P2S, P2NS	D1D	
DT		G124	P1S, P2S, P2NS	D1D	
DU		G125	P1S, P2S, P2NS	D1D	
DV		G126	P1S, P2S, P2NS	D1D	
DW		G127	P1S, P2S, P2NS	D1D	
DX		G128	P1S, P2S, P2NS	D1D	
DY		G129	P1S, P2S, P2NS	D1D	
DZ		G130	P1S, P2S, P2NS	D1D	

□ = EASY to perform simultaneously.

☒ = Can be performed simultaneously with PRACTICE.

☐ = DIFFICULT to perform simultaneously even after long practice. Allow both times.

Motions not included in above table: TURN — Normally EASY with all motions except when TURN is controlled or with DISENGAGE.

APPLY PRESSURE, CRANK — May be EASY, require PRACTICE, or DIFFICULT. Each case must be analysed.

POSITION — Class 3 — Always DIFFICULT. DISENGAGE — Class 3 — Normally DIFFICULT. RELEASE — Always EASY. DISENGAGE — Any class may be DIFFICULT if care must be exercised to avoid injury or damage to object.

W = Within the area of normal vision, i.e.  $r = 10$  cm,  $d = 40$  cm.

O = Outside the area of normal vision, i.e.  $r = 10$  cm,  $d = 40$  cm.

E = EASY to handle.

D = DIFFICULT to handle.

Source: Official International Metric Data, © International Union of Pure and Applied Chemistry and International Association for Standardization and Measurement.

