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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2024

INDUSTRIAL ENGINEERING
VII Semester
IE5701& APPLIED ERGONOMICS
(Regulation2019)

Time:3hrs   Max.Marks: 100

CO1	Utilize fundamental knowledge from human science and engineering science within the realm of ergonomics
CO2	Evaluate workplace ergonomic issues by employing ergonomic measurement methods
CO3	Ability to conduct an ergonomic analysis and ergonomic recommendations for modern work environment problems
CO4	Analyse the environmental factor and occupational health and safety regulation to improve overall workplace condition.
CO5	Ability to apply ergonomic principles to design workplaces for the improvement of human performance.

BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A(10x2=20Marks)
(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
1	List any two design problems arising from the introduction of computers in the workplace and the corresponding knowledge required to address them?	2	1	L2
2	Contrast between Ergonomics and Human factors Engineering.	2	1	L2
3	State the procedure for anthropometric design.	2	2	L1
4	What are the causes of Cumulative trauma disorders?	2	2	L1
5	The oxygen requirement for a manual task is 1.5 L/min and personnel have to work for period of ½ hour. What is the required rest period for both male and female?	2	3	L1
6	Compare between OWAS, RULA and REBA	2	3	L2
7	What are the three primary categories of product liability claims	2	4	L2
8	Give any two type of industrial task with range of illumination required.	2	4	L2
9	Write any two examples of Skill based error.	2	5	L2
10	Differentiate between Standard and Actual Full Time Equivalent (FTE).	2	5	L2

PART- B(5x 13=65Marks)
(Restrict to a maximum of 2 subdivisions)

Q.No.	Questions	Marks	CO	BL
11 (a)	A person of body height, H_B and body Weight W_B is working in the erect position with a worktable at a correct height and the thoracolumbar spine is inclined at an angle θ= 85°. The weight of the thorax and abdomen is 36 % of W_B. The weight of the head, neck and both the arm are 18% of W_B. The weight of any additional load is zero. Draw the free body diagram and calculate the extersor muscle force (F_e) directed at an angle∝ = 13°,axial	13	1	L3

	reaction force R_a and shear reaction force R_s at the base of the spine.			
	OR			
11 (b)	The job illustrated in Figure 11b consists of a worker inspecting compact containers(26 Lbs) for damage on a low shelf, and then lifting them with both hands directly in front of the body from shelf 1 to shelf 2 at a rate of 3/min for a duration of 45 minutes. For this analysis, assume that (1) the worker cannot take a step forward when placing the object at the destination, due to the bottom shelf, and (2) significant control of the object is required at the destination. The containers are of optimal design, but without handles. The horizontal distance at the origin of the lift is 10 inches and the horizontal distance at the destination of the lift is 20 inches. The height of shelf one is 22 inches and the height of shelf to is 59 inches. Since the container is of optimal design, but does not have handles or handhold cut outs, the coupling is defined as "fair" - 0.95. No asymmetric lifting is involved (i.e., A = 0). Significant control of the load is required at the destination of the lift. (1 lb= 0.4538 kg, 1 inch =2.54 cm). Find the Recommended Weight Limit (RWL) lifting Index (LI). List out the redesign suggestion for reducing the risk of injury for workers performing this task.	13	1	L3

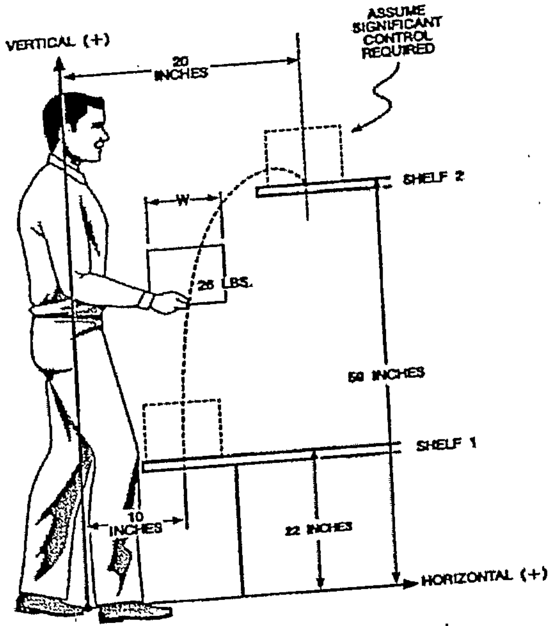

Figure 11b: Inspection work

Frequency (lifts/min)	Work duration < 1 hour V < 75	V < 75	< 2 hours V < 75	V < 75	< 8 hours V < 75	V < 75
0.2	1.00	1.00	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.81	0.81
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.80	0.80	0.60	0.60	0.35	0.35
6	0.75	0.75	0.50	0.50	0.27	0.27
7	0.70	0.70	0.42	0.42	0.22	0.22
8	0.60	0.60	0.35	0.35	0.18	0.18
9	0.52	0.52	0.30	0.30	0.00	0.15
10	0.45	0.45	0.26	0.26	0.00	0.13

Figure 11 b: Frequency Multiplier table

Q. No.	Question	Marks	CO	BL
12 (a)	i)Explain the physical factors that affect the Visual Display Terminal(VDT).	7	2	L3
	ii) You have been asked to advice a bank that wishes to replace all its existing office workstation with new sit stand workstation that enable workers to work either a standing or in a sitting position. Using these estimates specify the maximum allowable height for the desk in its lowest position and the minimum allowable height for the desk in its highest position.	6		

	Male	female
Mean popliteal height	48	44
SD Popliteal height	5	4
Mean elbow height	25	20
SD elbow height	2	2
Mean elbow height (standing)	120	95
SD elbow height (standing)	6	5

OR

Q. No.	Question	Marks	CO	BL
12 (b)	Explain the guidelines for Reducing RMI through Product Design, Process Engineering, Workstation Design and Use of Appropriate Handtools.	13	2	L3
13 (a)	i)A 25 year old forestry worker has a VO_2 /Heart rate regression equation of y= 1.42+0.025 x. wherey is oxygen consumption (litres O_2 /min) and x is the heart rate (beats / min) a. The workers heart rate is monitored while felling trees and is found to be 150 beats /min. Use the regression equation to estimate the workers oxygen consumption. b. Estimate the workers maximum heart rate and maximum workers VO_2 (max). c. Calculate the relative workload demand by expressing the oxygen consumption while working as a percentage of VO_2 max. d. Estimate the time to exhaustion.	8	3	L4
	ii) Explain the measures of physiological Strain.	5		
	OR			
13 (b)	i)A hand-operated, high-pressure hydraulic lever used for compacting materials in a recycling plant is operated by pushing forward with both hands, shoulder-width apart, and positioned at waist height. The design engineer wants to determine how long the operator can sustain the task if the required force is 18 kg. The maximum force required is simulated using a bathroom scale positioned between two stationary blocks. Volunteers exert a maximum push force, which is recorded from the scale. The maximum push forces (kg) for 10 male volunteers are 26, 20, 32, 24, 22, 27, 21, 33, 29, 28. Calculate the 5th and 95th percentile endurance times.	6	3	L4
	ii) Illustrate the various types of Health-related fitness test to evaluate the physical fitness of the person	7		
14 (a)	What are the potential incidences for Hand and Head hazards? Explain the different types of head and hand PPE.	13	4	L2
	OR			
14 (b)	Explain the safety and Welfare provisions according to factories act 1948?	13	4	L2
15 (a)	i)Explain the Human information processing Model conceived by	6	5	L3

Card, Moran, and Newell.

ii) Consider the Noise follow X_n (0,1) and Signal follows normal distribution X_s (d',1) data from the detection experiment shown in table 7a. Find the perceptual sensitivity (d') and decision criteria (λ). Draw a picture illustrating the model. — 7

Table 15a: Experiment data

	No	Yes	
Noise	36	64	100
Signal	24	76	100

OR

Q.No.	Question	Marks	CO	BL
15 (b)	Explain the principles ofdisplays with suitable examples.	13	5	L3

PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No.	Questions	Marks	CO	BL
16.	Suppose a worker has to perform a composite manual handling task for 3 hours: lifting raw materials, assembling them on a workstation, and stacking the finished products onto a storage rack. These tasks are interdependent as they contribute to the primary task called "Assemble and Store." Find the Composite Lifting Index (CLI). A task analysis provides the following information:A task analysis provides the following information shown in table 16.Analyse the provided task analysis data and justify the prioritization of ergonomic interventions for each subtask (lifting, assembling, and stacking) to minimize the worker's physical strain. Support your recommendations with calculations and ergonomic principles.	15	2	L5

Table16: Task analysis data

Description	H	V	D	A	F (lifts/Min)	C	Mass (Kg)
1. Lift Raw Material	30	30	75	45	2	0.9	10
2. Assemble Items	60	120	50	10	3	0.8	5
3.Stack Products	40	80	40	90	1	1	15

	Work duration					
	≤ 1 hour		≤ 2 hours		≤ 8 hours	
Frequency (lifts/min)	V < 75	V < 75	V < 75	V < 75	V < 75	V < 75
0.2	1.00	1.00	0.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
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8	0.60	0.60	0.35	0.35	0.18	0.18
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10	0.45	0.45	0.26	0.26	0.00	0.13

Figure 16: Frequency Multiplier table