AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT
IIT KHARAGPUR

End-Spring Semester Examination 2011-2012
4th Yr. B.Tech. (Hons.)

Date of Exam: 25.04.2012 AN
Subject No.: AG40002
Subject Name: Ergonomics in Engineering Design
No. of Students: 15

Max. Marks: 60
Time: 3 hrs

Instructions: Answer all questions. Answer must be brief and to the point. Make justified assumptions wherever required.

---

1. Selected anthropometric dimensions of a set of male tractor drivers is given in Table 1. Determine the operator work place dimensions for (i) seat height range, (ii) seat width, (iii) seat depth (front-rear), (iv) arm rest width and height, and (v) height inside a cab.

   [6]

Table 1

Sl No.	Body Measurement	Dimension, cm		
		5th Percentile	50th Percentile	95th Percentile
1.	Height	162	173	185
2.	Sitting height, erect	84	91	97
3.	Sitting height, normal	80	87	93
4.	Knee height	49	54	59
5.	Popliteal height	39	44	49
6.	Elbow-rest height	19	24	30
7.	Thigh-clearance height	11	15	18
8.	Buttock-knee length	54	59	64
9.	Buttock-popliteal length	44	50	55
10.	Elbow-to-elbow breadth	35	42	51
11.	Seat breadth	31	36	40
12.	Mass, kg	58	75	98

2. Show a typical representation of vibration data for tractor ride comfort by a one-third octave band rms acceleration versus frequency. Discuss its behaviour.

   [4]

3. The transmissibility (T) for a single degree of freedom linear spring-mass-damper system as a function of damping ratio. ε, tractor chassis frequency (ω_t), and undamped natural frequency of the operator seat (ω_s) is given by

$$T = \left[\frac{1 + 4\varepsilon^2 \left(\frac{\omega_t}{\omega_s}\right)^2}{\left[1 - \left(\frac{\omega_t}{\omega_s}\right)^2\right]^2 + 4\varepsilon^2 \left(\frac{\omega_t}{\omega_s}\right)^2} \right]^{0.5}$$

Graphically represent this behaviour and explain its importance in the design of a suitable seat suspension system. What is the undamped natural frequency of a tractor? Does the tractor operator experiences longitudinal and lateral vibrations? What is the normal range of these vibrations?

   [10]

4. An accelerometer mounted to the waist of a seated tractor operator records a vertical RMS acceleration of 1.5 m/s^2 at 8 Hz. What is the most likely source of this vibration? Would it be desirable for the operator to experience this level of vibration? If the above RMS acceleration were decreased by 10 dB because of improved seat design, what would be the resulting RMS acceleration? How many hours could the operator tolerate this level of vibration?

[10]

5. What is C06? How this concept is utilized in evaluating the ergonomic maturity of an industrial production system. Give all relevant assumptions and criteria in this evaluation.

[10]

6. Explain the concept of colour coding and shape coding in the design of an operator workstation. How do you take care of the thermal environment in the work station?

[10]

7. Write short notes on the following:
   (i)   System Reliability
   (ii)   5th and 95th Percentile Dimensions
   (iii) WBGT
   (iv)   Laboratory Calibration of Ergonomic Subjects
   (v)   ROPS

[10]

----------X----------