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#### **Farm Power**



Preface

presenting you the comprehen.

d in GATE examination. This wi.

GATE, ICAR JREVSRF, ARS., S

re Service, IBPS AFO & IFS.

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Wishing Landing Training of Carling Landing Continues to the continue of Carling Landing Continues to the continues of t We take immense pleasure in presenting you the comprehensive book containing all the questions that has been asked in GATE examination. This will help you in preparing for different exams such as GATE, ICAR JRF/SRF, ARS,, State Engineering Exams,

This book is written by Sagar Khurana, an alumni of IISc (Indian Institute of Science), Bangalore with a vision to provide quality examination content for Agriculture

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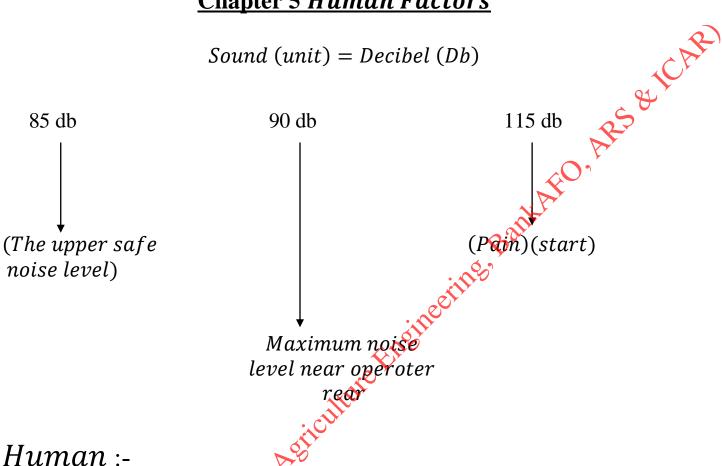


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## Chapter 5 Human Factors



# Human:-

Individuals comfartable  $Temp - (24^{\circ} - 27^{\circ})$ Vibration human tolerance -(4-8)Htz ce a Coching In body surfce area of a man =  $2m^2$ 



## **SPL** (Sound Pressure level)

standard reference sound Pressure

 $20\mu Pa~(2\times 10^{-5})Pascal$ 

 $Temp = 20^{\circ} Degree$ 

(Refernce Pressure)

Bank Ario, Ares & ICAR 2 x Petite. Pascal

2 x Po-5 Pascal

P ↑

Cachine Institute of CAME. Agriculture

Category M. Cochine Institute of CAME.



Sound Pressure level:-

$$SPL = 20\log_{10}\frac{P_{rms}}{P_0} = dB$$

 $P_0 = reference sound Pressure$ 

$$P_0 = 2 \times 10^{-5} \ N/m^2$$

$$SPL = dB$$

$$P_0 = 1 N/m^2$$

$$SPL = dBA$$

Variable Acceleration level:-

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EL:-

= 
$$dB$$

and Pressure

$$SPL = dB$$

$$SPL = dBA$$

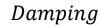
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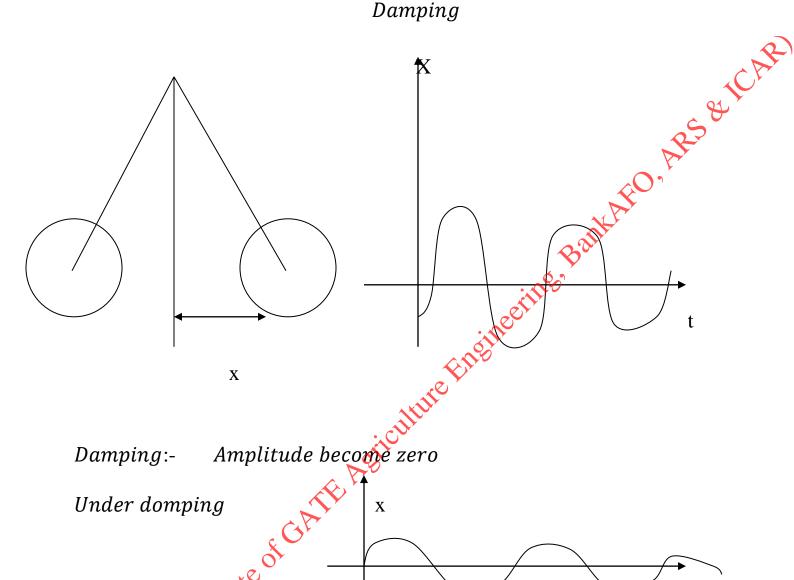
measured Rms acelera  $V_0 = reference$  acceleration

Catefor All Coching Institute

Catefor All Coching Institute  $V_0 = V_0 = V_0$ V = measured Rms aceleration

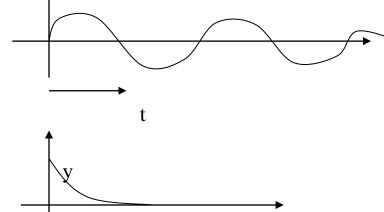






Damping:-

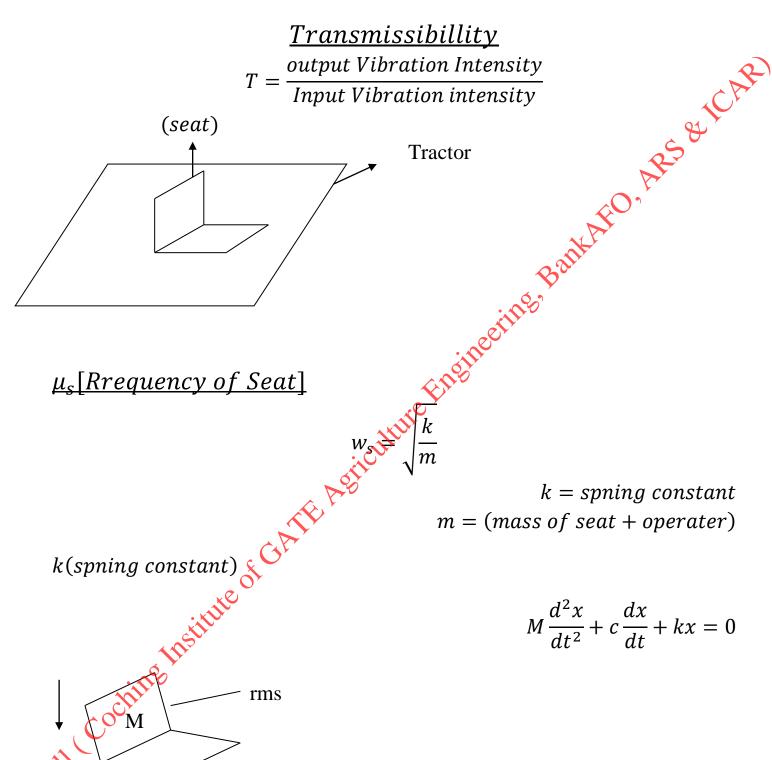
Je Institute of CATIE Under domping Critical domping

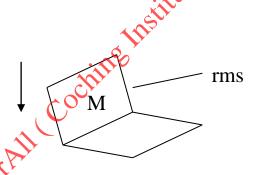


$$Damping \ ratio = \in = \frac{Under \ domping}{critical \ domping}$$



# **Transmissibillity**





$$M\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$$

$$T = 2\pi \sqrt{\frac{m}{k}}$$

$$w = \frac{T}{2\pi} = \sqrt{\frac{m}{k}}$$



Farm Power 
$$T = \left[\frac{1 + \left[2 \in \left(\frac{wt}{ws}\right)^2\right]^2}{\left[1 - \left(\frac{wt}{ws}\right)^2\right]^2 + \left(2 \in \frac{wt}{ws}\right)^2}\right]^{0.5}$$

$$\in = domping\ ratio$$

$$w_t = frequency\ of\ tractor$$

$$w_s = frequency\ of\ seat$$

$$w_s = \sqrt{\frac{\kappa}{m}}$$

$$k = spring\ constant$$

$$m = operter + seat$$

$$e = \frac{C[seat\ domping]}{C_c[Critical\ domping]}$$

$$C_c = 2\ mw_s$$

$$w_s[frequency\ of\ seat]$$

$$w_s = \sqrt{\frac{\kappa}{m}}$$

$$w_S = \sqrt{\frac{k}{m}}$$

$$\in = \frac{C[seat\ domping]}{C_c[Critical\ domping]}$$

$$w_s = \sqrt{\frac{k}{m}}$$



$$C_c = 2. m. w_s$$

$$T = \left[ \frac{1 + 4 \in^2 \left(\frac{wt}{ws}\right)^2}{\left[1 - \left(\frac{wt}{ws}\right)^2\right]^2 + 4 \in^2 \left(\frac{wt}{ws}\right)^2} \right]^{0.5}$$

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### **Farm Power**

#### Numerical

- Q1. Sound was measured at 80 DBA and 76dBA in the operator's cabin on a tractor. What is the RMS sound pressures correspond to both the sound pressure level [GATE 1998]
- Q2. Sound was measured at 80 DB in the operator's cabin on a tractor. What is the RMS sound pressure and also determine the resultant sound pressure in decibels, if the sound pressure is increased eight times [GATE 2001]
- Q3. The measures value of the acceleration at the cab floor of the tractor is 2 m/ s<sup>2</sup> If the ratio of the frequency of the tractor chassis and the under amped natural frequency of the set is 2 and the damping ratio is zero. Find out the vibration intensity experienced by the operator (A)  $0.4 \text{ M/S}^2$  (B)  $0.66 \text{ M/S}^2$  (C)  $0.88 \text{ M/S}^2$  (D)  $1.16 \text{ M/S}^2$  [GATE2006]
- Q4. The differential equation of motion for a single degree of freedom mass-spring damped system is 8  $\frac{D^2x}{Dt^2} + 5\frac{Dx}{Dt} + 12t = 0$ . If the units of mass, length and time are Kg3 m and sec respectively. The natural frequency of the vibration is in
- (A) 0.42 rad /sec (B) 0.52 rad /sec (C) 1.22 rad /sec (D) 1.83 rad /sec

[GATE2006]

- Q5. A tractor seat suspension system with a seat and operator mass of 90 kg has a seat suspension damping rate of 350 N s m-1. If the spring rate of the system is 5 N mm 1, the damping ratio of the system is [GATE 2009]
- (A) 0.13 (B) 0.26 (C) 0.39 (D) 0.52
- Q6. The tractor seat vibrates with a frequency of 1 Hz when there is no damping, when damping is provided the frequency of damped vibration is reduced by 10%. The damping factor is

[GATE 2010]

- (A) 0.21 (B) 0.39 (C.) 0.4-4 (D) 0.93
- Q7. The range of frequency of vertical vibration of tractor most harmful to the operator's body at a root mean square acceleration of 1.0 m –s-2 in Hertz [GATE 2011]
- (A) 0.4 0.8 (B) 4.0 8.0 (C) 400 800 (D) 4000 8000
- Q8. During a test, sound level was measured as 90 dB in the operator's cabin on a tractor. Taking reference sound pressure as  $2 \Box 10 \Box 5$  N m-2, the measured RMS sound pressure in N m/Sec<sup>2</sup> is [GATE 2013]
- (A)  $632^{\circ}$  (B)  $6.32*10^{-1}$  (C)  $1.8*10^{-3}$  (D)  $6.32*10^{-10}$
- Q9. For a reference sound pressure of  $2\times10-5$  N m-2, the sound level measured at the operator's workspace of a tractor was 80 dB. If the RMS sound pressure is increased by eight times, the resulting sound pressure level in dB, will be . [GATE 2015]
- Q10. Natural frequency of an undamped operator seat is 5 Hz, and combined weight of the seat and the operator is 880 N. If there are four springs fitted in parallel below the operator seat, the spring rate (or stiffness) of each spring in kN m-1 is \_\_\_\_\_\_ [GATE 20]

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$$SPL = 84 dBA$$

$$SPL = 20\log_{10}\left(\frac{P}{1}\right)$$

$$\frac{84}{20} = \log_{10} P$$

$$P = 15848.931912 Pascal$$

$$SPL = 20 \log_{10} \left( \frac{P}{P_0} \right)$$

Farm Power

Q. 1 
$$\rightarrow$$
 GATE 1998

 $SPL = 84 \, dBA$ 
 $SPL = 20 \log_{10} \left(\frac{P}{1}\right)$ 
 $\frac{84}{20} = \log_{10} P$ 
 $P = 15848.931912 \, Pascal$ 
 $SPL = 20 \log_{10} \left(\frac{P}{P_0}\right)$ 

if  $DBA$   $P_0 = 1$ 
 $76 = 20 \log_{10} \left(\frac{P}{P_0}\right)$ 
 $P_2 = 6309 \, N_2 m^2$ 

GATE 1998

Craterial and the property of t

$$P_2 = 6309 \ N m^2$$



$$SPL = 20 \log \left(\frac{P}{P_0}\right)$$

$$SPL = 80 DB$$

$$P_0 = 2 \times 10^{-5} \ N/m^2$$

Farm Power

Q. 2 
$$\rightarrow$$
 GATE 2001

 $SPL = 20 \log \left(\frac{P}{P_0}\right)$ 
 $SPL = 80 DB$ 
 $P_0 = 2 \times 10^{-5} \ N/m^2$ 
 $SPL = 20 \log_{10} \left(\frac{P}{2 \times 10^{-5}}\right)$ 
 $80 = 20 \log_{10} \left(\frac{P}{2 \times 10^{-5}}\right)$ 
 $80 = 20 \log_{10} \left(\frac{P}{2 \times 10^{-5}}\right)$ 
 $10^4 \times 2 \times 10^{-5} = P$ 
 $P = 0.2 \ N/m_0^2$ 

Consecuting training.

$$80 = 20 \log_{10} \left( \frac{P}{2 \times 10^{-5}} \right)$$

$$\frac{80}{20} = \log_{10} \left( \frac{P}{2 \times 10^{-5}} \right)$$

$$10^4 \times 2 \times 10^{-5} = P$$



**GATE 2001** 

$$P = 0.2 \times 8$$

$$P = 1.6 \ N/m^2$$

$$SPL = 20 \log_{10} \left( \frac{1.6}{2 \times 10^{-5}} \right)$$

$$= 98 db$$

$$SPL = 98 dh$$

Crave for Ant. Coolings Institute of Crafts. Agriculture Engineering. Bank Arto. Ages & L.C. Agriculture Engineering.



 $0.3 \rightarrow$ 

**GATE 2006** 

$$\alpha = 2 \, m/sec$$

$$\in = 0$$

$$\frac{wt}{ws} = 2$$

$$Q.3 \rightarrow GATE 2006$$

$$\alpha = 2 \, m/sec$$

$$E = 0$$

$$T = \left[ \frac{1 + 4 \, e^2 \left( \frac{wt}{ws} \right)^2}{\left[ 1 - \left( \frac{wt}{ws} \right)^2 \right]^2 + 4 \, e^2 \left( \frac{wt}{ws} \right)^2} \right]^{0.5}$$

$$T = \left[ \frac{1}{\left[ 1 - \left( \frac{wt}{ws} \right)^2 \right]^2} \right]^{0.5}$$

$$T = \frac{1}{1 - (2)^2} = \left( \frac{1}{2} \right)^{0.5}$$

$$T = \frac{1}{3} = \underbrace{\frac{0 \, \text{unitable Intensity}}{2}}_{0.5}$$

$$T = \frac{1}{3} = \underbrace{\frac{0 \, \text{unitable Intensity}}{2}}_{0.5}$$

$$T = \frac{1}{3} = \underbrace{\frac{0 \, \text{unitable Intensity}}{2}}_{0.66 \, \text{m/sec}^2}$$

$$T = \left[\frac{1}{\left[1 - \left(\frac{wt}{ws}\right)^2\right]^2}\right]^{0.5}$$

$$T = \frac{1}{1 - (2)^2} = \left(\frac{1}{9}\right)^{0.5}$$

$$T = \frac{1}{3} = \frac{\text{output Intensity}}{2}$$

$$output = \frac{2}{3} = 0.66 \, m/sec^2$$



$$8\frac{d^2x}{dt^2} + 5\frac{dx}{dt} + 12x = 0$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$k = 12$$

$$m = 8$$

Q.4 
$$\rightarrow$$
 GATE 2008
$$8\frac{d^2x}{dt^2} + 5\frac{dx}{dt} + 12x = 0$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$k = 12$$

$$m = 8$$

$$w_x = \sqrt{\frac{12}{8}} = 0.22 \, rad/sec$$

$$w_x = \sqrt{\frac{12}{8}} = 0.22 \, rad/sec$$
Constitute Engineering.



 $Q.5 \rightarrow$ **GATE 2009** 

 $\epsilon = \frac{C_s}{C_c} = \frac{Seat \ dompting \ rate}{Critical \ dompting \ rate}$   $m = \frac{1}{\sqrt{3}}$  $c_{c} = 2\sqrt{90 \times 5000}$   $c_{c} = \sqrt{\frac{k}{m}}$   $k = \sqrt{\frac{k}{m}}$ 

$$C_c = 2 m w_x$$

$$=2m\sqrt{\frac{k}{m}}$$

$$C_c = 2\sqrt{90 \times 5000}$$

$$C_c = 1341 \frac{N-s}{m}$$

$$E_s = 350$$

$$m = 20$$

$$k = 5 N/mm$$

$$k = 5 \ N/10^{-3} \ k = 5000$$

$$6 = \frac{350}{1341} = 0.26$$



$$Q.6 \rightarrow \qquad \qquad \text{GATE 2010}$$

$$\epsilon = \sqrt{1 - \left(\frac{wt_{domping}}{ws_{seat}}\right)^2}$$

$$\epsilon = \sqrt{\left(1 - \frac{(0.9)^2}{1}\right)}$$

$$= \sqrt{1 - 0.81}$$

$$= \sqrt{0.19}$$

$$\epsilon = 0.43$$

$$\epsilon = 0.43$$
Contains the first the first that the first thad the first that the first that the first that the first that th

$$\in = 0.43$$



 $Q.8 \rightarrow$ 

**GATE 2013** 

$$SPL = 90dB$$

$$SPL = 20 \log \left( \frac{P_{rms}}{P_0} \right)$$

$$90 = 20 \log_{10} \left( \frac{P}{P_0} \right)$$

GATE 2013

Human factors

$$SPL = 90dB$$

$$SPL = 20 \log \left(\frac{P_{rms}}{P_0}\right)$$

$$90 = 20 \log_{10} \left(\frac{P}{P_0}\right)$$

$$\frac{90}{20} = \log_{10} \left(\frac{P}{P_0}\right)$$

$$P_0 = 2 \times 10^{-5}$$

$$P = 3 \times 22 \times 10^{-5} \times 2$$

$$P = 6.32 \times 10^{-1} N/m^2$$

Constitute the first the factors of the property of the

$$P_0 = 2 \times 10^{-5}$$

$$P = 31622 \times 10^{-5} \times 2$$

$$6.32 \ N/m^2 \times 10^{-1}$$

$$P = 6.32 \times 10^{-1} \, N/m^2$$



 $0.9 \rightarrow$ 

**GATE 2016** 

$$f = 5Ht_3$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$2\pi f = \sqrt{\frac{k}{m}}$$

$$2\pi \times 5 = \sqrt{\frac{k^1}{m}}$$

$$m = \frac{880}{9.8} = 89.79 \ kg$$

$$2\pi \times 5 = \sqrt{\frac{k^1}{89.79}}$$

$$k^1 = 88.619$$

$$Q.9 \rightarrow GATE 2016$$

$$m_{s+o} = 880 N$$

$$f = 5Ht_3$$

$$w_s = \sqrt{\frac{k}{m}}$$

$$2\pi f = \sqrt{\frac{k}{m}}$$

$$2\pi \times 5 = \sqrt{\frac{k^1}{m}}$$

$$2\pi \times 5 = \sqrt{\frac{k^1}{89.79}}$$

$$k^1 = 88.619$$

$$k_{each spring} = \frac{10^{k+1}}{4} = 22154 N/m'$$

$$k_{each} = 22.54 KN/m$$

$$k_{each} = 22.54 \ KN/m$$

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### **Farm Power**

$$SPL = 20 \log_{10} \left( \frac{P}{P_0} \right)$$

$$80 = 20 \log_{10} \left( \frac{P}{2 \times 10^{-5}} \right)$$

$$P = 0.2$$

$$P_{new} = 8 \times 0.2 = 1.6$$

$$Q.10 \rightarrow GATE 2015$$

$$SPL = 20 \log_{10} \left(\frac{P}{P_0}\right)$$

$$80 = 20 \log_{10} \left(\frac{P}{2 \times 10^{-5}}\right)$$

$$P = 0.2$$

$$P_{new} = 8 \times 0.2 = 1.6$$

$$SPL_{new} = \log_{10} \left(\frac{1.6}{2 \times 10^{-5}}\right)$$

$$SPL_{new} = 98.06 \, dB$$

$$SPL_{new} = 98.06 \, dB$$

$$GATE 2015$$

$$GATE 2015$$

$$P_{new} = 8 \times 0.2 = 1.6$$

$$Q.10 \rightarrow GATE 2015$$

$$Q.10 \rightarrow$$

$$SPL_{new} = 98.06 \, dB$$