Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2023

Course: Vehicle Dynamics **Semester: V**
Program: B.Tech ADE **Time: 03 hrs**
Course Code: MEAD3001 **Max. Marks: 100**

Instructions: Wherever applicable, must draw appropriate free body diagram and work with symbols before substituting numerical values.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	The ratio of two successive amplitudes for free vibrations of a system is 1.2. Calculate the damping factor.	**4**	**CO2**
Q 2	Explain ply steer and conicity.	**4**	**CO1**
Q 3	Analyze the effect of locking up of front tires during braking.	**4**	**CO2**
Q 4	Explain the Ackerman condition for low speed turning.	**4**	**CO1**
Q 5	Draw a rough sketch of a 7 DOF system for analyzing vertical dynamics of a car and state the 7 motions that can be analyzed with this model.	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6	A car with mass = 2000 kg, wheel base = 2.8 m has 55% of weight distribution on front tires. Lateral stiffness of front and rear tires is $C_f = 40\ kN/rad$ and $C_r = 35\ kN/rad$. Calculate the understeer coefficient and critical speed or characteristic speed as applicable.	**10**	**CO3**
Q 7	Design a brake system having ideal brake force distribution under the following condition. 60% of the vehicle static load is on the rear axle. The ratio of height of CG to wheel base, h/L=0.25. Coefficient of friction $\mu = 1.05$, coefficient of rolling resistance $f_r = 0.03$. (Note: Design here means determination of K_{bf} and K_{br})	**10**	**CO4**
Q 8	Analyze the effect of stress frequency and temperature on behaviour (modulus and hysteresis) of rubber.	**10**	**CO2**
Q 9	A 150-kg machine is mounted on an elastic foundation of stiffness $3\ x\ 10^6$ *N/m*. When operating at 100 *rad/s*, the machine is subject to a harmonic force of magnitude 1500 N. The steady-state amplitude of the machine is measured as 2 mm. Calculate the damping ratio of the foundation?	**10**	**CO3**

	OR A machine runs at 4000 rpm. Its forcing frequency is very near to its natural frequency. If the nearest natural frequency of the 2 DOF system is to be at least 10% from the forced frequency, design a suitable vibration absorber. Mass of machine is 50 kg.		
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	A driver, by mistake, got on to a high slope road in Himalayas, having a downward slope of 40^o. The brake system of the car is adaptive and able to give ideal performance (maximum braking force on the front as well as rear wheels simultaneously). The driver achieves a maximum deceleration of 0.5 m/s^2. Neglect the aerodynamic drag. Determine (a) The load on front and rear axle (b) The coefficient of friction between tire and road. (c) The available braking force The relevant data is the following – Mass of car, m = 1400 kg Wheel base, L = 2.8 m Distance of CG from front axle, l_1 = 1.45 m Height of CG, h = 0.25 m Coefficient of rolling resistance, $f_r = 0.02$ Use g = 10 m/s^2	**20**	**CO4**
Q 11	Calculate the pitch and bounce frequencies, mode shapes and the locations of oscillation centers of an automobile with the following data. Note: Must derive the equation of motion first by drawing appropriate free body diagram. Sprung mass, $m_s = 2100\ kg$ Radius of gyration, $r_y = 1.45\ m$ Distance from front axle to CG = 1.35 m Distance from rear axle to CG = 1.45 m Front spring stiffness, $k_f = 42\ kN/m$ Rear spring stiffness, $k_r = 38\ kN/m$ **OR** Vertical dynamics in a vehicle is modeled using the quarter car model.	**20**	**CO3**

	The Sprung mass, $m_s = 2400\ kg$, Unsprung mass, $m_{us} = 300\ kg$, Suspension system stiffness, $k_s = 100\ kN/m$, Tire stiffness, $k_t = 800\ kN/m$. Damping coefficients are c_s, c_t. (a) Calculate the natural frequencies using approximate method. (b) Derive the equations of motion (c) Using equations from part (b), determine the natural frequencies and mode shapes. Also compare the results of (a) and (c).		