MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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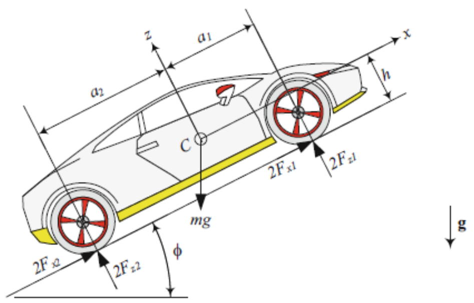
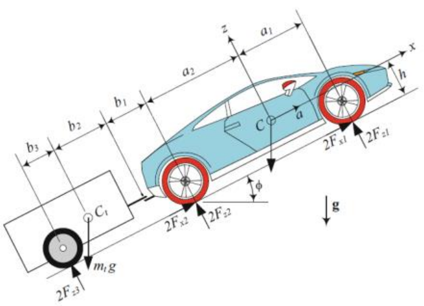
DEPARTMENT OF MECHATRONICS
VI SEMESTER B.TECH. MECHATRONICS
END SEMESTER MAKE-UP EXAMINATION, JUNE 2024
SUBJECT: Vehicle Dynamics **Subject Code: MTE 4054**
Date:
Time: 180 Mins **Exam time:** **MAX. MARKS: 50**

- Answer **ALL** questions.
- Missing data if any, maybe suitably assumed.

Q. No.		M	CO	PO	LO	BL
1A.	For a vehicle taking a turn with a constant radius, explain the relationship between steer angle and radius of turn for a neutral steer, understeer, and oversteer condition. Draw the curvature response at a fixed steer angle.	5	4	4	4	2
1B.	Consider an accelerating car on an inclined road as shown in Figure 1B. Determine the vertical forces acting on the front and rear wheels. (Neglect the aerodynamic, d Alembert's force, and braking force.)  ***Fig.1B***	3	1	2	2	4
1C.	Explain the concept of the roll, pitch, and yaw motions for the vehicle.	2	4	4	4	2
2A.	For a car-trailer combination accelerating on an inclined road, draw the free-body diagram and derive the expression for normal forces acting on the wheels of the car and trailer. Refer fig. 2A. Assume h1 = h2 = h3 = h.  Fig, 2A	5	1	2	2	4

2B.	Consider a car with the following characteristics: Wheelbase = 2272 mm; the center of gravity is at the center of the car and has a height of 220 mm above the ground level. If the coefficient of friction, $\mu_x = 1$, and the mass of the car, m = 1500 kg. Calculate the minimum time required to reach the speed of 0 – 100 km/hr, assuming that the car is a rear-wheel drive car.	**3**	**1**	**2**	**2**	**3**
2C.	A car is parked on an uphill road. Determine the force on front and rear axles, if m = 1665 kg, wheelbase = 2.48 m, the distance between front wheels and center of gravity is 1.35 m. The angle with the horizontal is 30°. The centre of gravity is at a height of 0.5 m from the ground. (Neglect the aerodynamic, d Alembert's force, tractive and braking forces, and rolling resistance forces.)	**2**	**1**	**2**	**2**	**3**
3A.	Explain the phenomena of adhesion and hysteresis in a tire.	**4**	**2**	**4**	**4**	**2**
3B.	A sports car weighs 9.919 kN and has a wheelbase of 2.26 m. The center of gravity is 1.13 m behind the front axle. The cornering stiffness of each front tire is 58.62 kN/rad and that of each rear tire is 71.36 kN/rad. Determine the steady-state yaw velocity gain and lateral acceleration gain of the vehicle. The forward speed of the vehicle is 90 km/hr.	**3**	**4**	**2**	**2**	**3**
3C.	Derive the expression for Ackermann Steering Geometry.	**3**	**4**	**4**	**4**	**3**
4A.	A passenger car weighs 21.24 kN and has a wheelbase of 2.87 m. The center of gravity is 1.27 m behind the front axle and 0.508 m above the ground level. The braking effort distribution on the front axle is 60%. The coefficient of rolling resistance is 0.02. Determine which set of tires will lock first on a road surface when the coefficient of road adhesion is: i. $\mu = 0.8$ and ii. $\mu = 0.2$.	**5**	**1**	**2**	**2**	**3**
4B.	For steady-state handling characteristics of a two-axle vehicle represented as a Bicycle Model, derive the expression for cornering forces and slip angles for front and rear wheels.	**3**	**4**	**4**	**4**	**3**
4C.	Explain anti-squat and anti-dive suspension geometry.	**2**	**1**	**4**	**4**	**2**
5A.	Discuss the factors that affect the steady-state handling characteristics of a vehicle.	**5**	**4**	**2**	**2**	**3**
5B.	In what way do the wheels of a car (front and rear) get locked up? Why does the rear wheel lockup be a critical situation, particularly on a road with a low coefficient of adhesion?	**3**	**1**	**4**	**4**	**2**
5C.	Explain the ISO 2631 standard for the evaluation of vibrational environments in transport and industry vehicles.	**2**	**1**	**4**	**4**	**2**