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VI SEMESTER B.TECH. (MECHATRONICS ENGINEERING) END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: VEHICLE DYNAMICS [MTE 4026]

(26/04/2018)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Data not provided may be suitably justified and assumed.
- 1A Determine the front and rear suspension ride rates for a 5.0 L Mustang given that the spring rate is 210 N/mm. The front suspension rate is 25 N/mm and the rear is 17 N/mm. Also, estimate the natural frequencies of the two suspensions when the front tires are loaded to 4250 N and the rear tires are loaded at 3250 N.
- 1B Draw the circuit diagram of the hydraulic modulator with a 2/2 solenoid valve in an 04 antilock braking system. Explain term pressure release setting and pressure application setting.
- **1C** Differentiate between radial and non radial tires.
- 2A Rolls Royce Phantom has a weight of 8450 N in the front axle and 6900 N in the rear axle with a wheel base of 2.5 m. Cornering stiffness on the front axle of the tire is 232 N/degree and rear axle is 195 N/degree. Evaluate the following cornering properties of the vehicle:
 - i. Ackermann Steering Angle for 152 m turn radius
 - ii. Understeer Gradient
 - iii. Characteristic Speed
 - iv. Critical Speed

(Take $g = 9.8 \text{ m/s}^2$)

2B Consider a car with the following characteristics: Wheel base = 2300 mm; $a_1 = a_2$; h = 200 mm; $\mu_x = 0.5$; m = 1500 kg. Assume the car is a rear wheel drive. Determine the time taken to reach the speed of 0 - 100 km/hr. 02

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- **2C** With respect to traction control system, explain the term drive slip.
- **3A** Consider a parked car on an uphill road (Figure 3A). If the forces under the front and **05** rear wheels are F_{z1} and F_{z2} , then prove that the inclined angle of the road is:



Figure 3A

- 3B A rear wheel drive Hyundai is taking a turn. Elaborate on the concept of roll, pitch, 03 and yaw motions for the vehicle. Along which axis the centrifugal and centripetal forces will act?
- 3C State the reason behind using tire cords in the manufacturing of tires. List the materials 02 that are used in manufacturing a tire cord.
- **4A** Explain the quarter car model and write the differential equations of the sprung and un **05** sprung mass for the quarter car model.
- **4B** Volkswagen Touareg is an all-wheel drive car with: Mass of car, m = 2300 kg, wheel base = 3000 mm. Assume $a_1 = a_2$ and the car is pulling a trailer with: Mass of trailer, $m_t = 600 \text{ kg}$; $h_1 = h_2$, $b_1 = 900 \text{ mm}$, $b_2 = 1300 \text{ mm}$, $b_3 = 200 \text{ mm}$. If the car is accelerating on a level road with acceleration, $a = 2\text{m/s}^2$, calculate the force(s) at the hinge.
- 5A Mercedes Benz E Class of mass 1400 kg, wheel base of 2600 mm is parked on an uphill road. Assume $a_1 = a_2$ and h = 500 mm. Compute the forces F_{z1} , F_{z2} and F_{x2} ; if the car is parked on an uphill with $\phi = 30^{\circ}$ and the handbrake is connected to the rear wheels. What would be the maximum load grade ϕ_M that the car can be parked, if $\mu_{x2} = 0.5$?
- 5B Summarize the involvement of light alloy material in the manufacturing of vehicular 04 rims. Justify your answer in the context of aluminum, composites, and magnesium.

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