R13

Code No: 115CH

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, March - 2017

VEHICLE DYNAMICS

(Automobile Engineering)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1.a) Find the tire height h_T and diameter D for the tire P215/65R15 96H. [2]
b) Explain classification of vehicles by FHWA. [3]
c) Explain the relation between Optimal Drive and Brake Force Distribution. [2]
d) Explain the relation between Volumetric, thermal, and mechanical efficiencies. [3]
e) What are the forces acting on a rigid vehicle? Explain. [2]
f) Write about steady state turning. [3]
g) Define rolling. [2]
h) Explain about time response of vehicle roll dynamics. [3]
i) What is damping? [2]
j) Explain the importance of the critical damping. [3]

PART - B

(50 Marks)

2.a) With the help of line diagram explain about Radial and Non-Radial Tires.
b) Explain the effect of tire structure, size, wear, and temperature on the rolling friction-coefficient. [5+5]

OR

3.a) Explain SAE standards for tyre design.
b) Alfa Romeo Spider™ has the following characteristics.
m = 1690kg ≈ 3725.8 lb, l = 2530mm ≈ 99.6 in, Tires = P225/50R17
Determine the rolling resistance coefficient μ_r for the front and rear tires of the car at zero and at top speed v_M. v_M = 235.0km/h ≈146.0mi/h Assume a1/a2 =1 .2 and use p = 27psi. [5+5]

4.a) Consider a car with the following specifications that is parked on a level road. Find the load on the front and rear axles.
m = 1765kg l =2 .84m a1 =1 .22m a2 =1 .62m
b) Define acceleration capacity. [5+5]

OR

5. A model of Jaguar XJ™ is a rear-wheel drive car with a 4.2-liter V 8 engine. Some of the car's specifications are close to the following values.
m = 3638lb, l = 119.4in, Front tire = P235/50R18, Rear tire = P235/50R18
PM = 300hp at ωM = 6000 rpm, If gear ratios of the car's gearbox are
1st gear ratio = n1 =4 .17, 2nd gear ratio = n2 =2 .34, 3rd gear ratio = n3 =1 .52
4th gear ratio = n4 =1 .14, 5th gear ratio = n5 =0 .87, 6th gear ratio = n6 =0 .69
Reverse gear ratio = nr =3 .40, final drive ratio = nd =2 .87
Check the gearbox stability condition. In case the relative gear ratio is not constant, determine the new gear ratios using the relative ratio of the first two gears. [10]

6. Use the Lagrange method and find the equation of motion for the pendulum shown in Figure 1. The stiffness of the linear spring is k. [10]

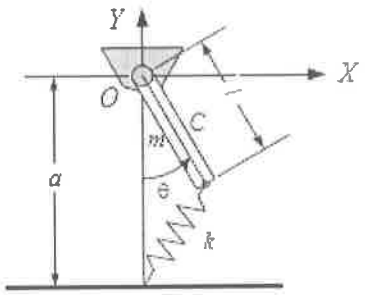

Figure 1:
A compound pendulum attached with a linear spring at the tip point

OR

7. a) Derive the expression for equation of motion of a pendulum attached to an oscillating mass
b) Find the principal moments of inertia and directions for the following inertia matrix:
[5+5]

$$(I) = \begin{pmatrix} 3 & 2 & 2 \\ 2 & 2 & 0 \\ 2 & 0 & 4 \end{pmatrix}$$

8. Derive Euler's equation of Motion of a six DOF vehicle. [10]

OR

9. Consider a bicycle model of a car such that tires are always upright and remain perpendicular to the road surface. Develop the equations of motion for the roll model of the car. [10]

10. Determine the potential energy of the pendulum in Figure 2, at an angle θ, if:
a) The free length of the spring is l = a−1.2b.
b) The free length of the spring is l = a−0.8b [10]

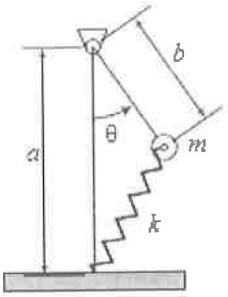

Figure 2: Spring connected pendulum

OR

11. Consider a bicycle car model with the following characteristics:
m = 1085/2kg, m1 = 40kg, m2 = 40kg; Iy = 1100kgm^2
distance from mass center to front axle a1 = 1 .4m, distance from mass center to reart axle a2 =1 .47m, k1 = 10000N/m, kt1 = kt2 = 150000N/m
Determine its natural frequencies and mode shapes for (a) k2 = 8000N/m
(b) k2 = 10000N/m (c) k2 = 12000N/m. (d) Compare the natural frequencies for different k1/k2 and express the effect of increasing stiffness ratio on the pitch mode. [10]

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