KUMARAGURU
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Register Number: …….

B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2009)

Seventh Semester

AUTOMOBILE ENGINEERING

AUE117**:** Vehicle Dynamics

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Damping ratio for a system with viscous damping is the ratio of
   a) Actual damping coefficient to critical damping coefficient.
   b) Critical damping coefficient to actual damping coefficient.
   c) Actual damping coefficient to ideal damping coefficient.
   d) Critical damping coefficient to ideal damping coefficient.
2. In the case of vehicle vibration with single degree of freedom and under damping, the motion is
   a) Aperiodic.
   b) Between aperiodic and oscillating.
   c) Oscillating.
   d) Sinusoidal and aperiodic.
3. If ‘b’ is the wheel base of the vehicle, ‘l’ is the distance between line of action of weight ‘W’ through centre of gravity and the contact point of the rear tyre with the ground, ‘μ’ coefficient of adhesion, ‘h’ height of centre of gravity from ground, then the reaction at the rear wheel is
   a) $\left(\frac{l-\mu h}{b-\mu h}\right)W$
   b) $\left(\frac{b-l}{b-\mu h}\right)W$
   c) $\left(\frac{b-l+\mu h}{b+\mu h}\right)W$
   d) $\left(\frac{b-l}{b-2\mu h}\right)W$
4. The limiting angle ‘θ’ for overturning during moving of a vehicle on a slope is (b- wheel base; l- distance between; h- height of C.G from ground
   a) $\sin^{-1}\left(\frac{b-l}{h}\right)$
   b) $\cos^{-1}\left(\frac{b-l}{h}\right)$
   c) $\tan^{-1}\left(\frac{l-b}{h}\right)$
   d) $\tan^{-1}\left(\frac{b-l}{h}\right)$
5. In Eigen value problems, Eigen vector represents
   a) Natural frequency for a particular mode shape.
   b) Mode shape for a given frequency.
   c) Damped natural frequency for a
   d) Undamped natural frequency for a

particular mode shape.

6. Influence coefficient α_{ij} is
   a) Lateral deflection of a structure at station 'j' due to unit load applied at station 'i'
   b) Longitudinal deflection of a structure at station 'i' due to unit load applied at station 'j'
   c) Lateral deflection of a structure at station 'i' due to unit load applied at station 'j'
   d) Longitudinal deflection of a structure at station 'j' due to unit load applied at station 'i'
7. Effective spring rate at wheel is equal to
   a) $\frac{\text{Suspension spring rate}}{\text{installation ratio}}$
   b) $\frac{\text{Suspension spring rate}}{(\text{installation ratio})^2}$
   c) $\frac{\text{Installation ratio}}{\text{Suspension spring rate}}$
   d) $\frac{(\text{Installation ratio})^2}{\text{Suspension spring rate}}$
8. During under steer handling behavior of a vehicle, the under steer coefficient is
   a) Zero
   b) Less than zero
   c) Greater than zero
   d) L/R; L- wheel base, R- Turning radius.
9. The exact frequency of a system lies in
   a) Dunkerley's lower bound method
   b) Rayleigh's upper bound method
   c) Between Dunkerley's and Rayleigh's method
   d) Holzer method
10. In a multidegree of freedom system with [M] and [K] representing its mass & stiffness matrices, {x} be modal vector, Rayleigh's upper bound approximation method, Rayleigh's quotient(ω^2) is equal to
   a) $\frac{\{X\}^T[M]\{X\}}{\{X\}^T[K]\{X\}}$
   b) $\frac{\{X\}[M]\{X\}^T}{\{X\}^T[K]\{X\}}$
   c) $\frac{\{X\}^T[K]\{X\}}{\{X\}^T[M]\{X\}}$
   d) $\frac{\{X\}^T[K]\{X\}}{\{X\}[M]\{X\}^T}$

PART B (10 x 2 = 20 Marks)

11. Define logarithmic decrement.
12. What do you mean by Transmissibility?
13. Define 'Tractive effort' and write the equation to calculate the same.
14. Write the equation for reaction at front and rear wheels of a four wheeled vehicle having weight 'W', wheel base 'b' and 'l' distance between the line of action of weight 'W' through centre of gravity and the contact point of the rear tyre with

the ground.

15. What do you mean by far coupled system?
16. What is meant by orthogonality of mode shapes?
17. Define sprung mass frequency of a vehicle
18. What do you mean by oversteer of a vehicle?
19. Write the equation to find the fundamental frequency of a system using Dunkerley's lower bound approximation.
20. What do you mean by branched system?

PART C (5 x 14 = 70 Marks)

21. a) Discuss in detail vehicle free vibration with single degree of freedom and draw the graphical representation for over damping, critical damping and under damping motions.

(OR)

b) The springs of a motor vehicle carry a total load of 11281.5 N and with equal springing front and rear; the combined spring rate is 88290 N/m. Calculate the frequency of vertical natural vibration with the dampers removed. If the dampers are adjusted to give a total damping force 4415.5 N/m/s, calculate the frequency of damped vibrations and the ratio of the second downward movement to the first downward movement.

22. a) Discuss in detail the stability of a vehicle over a slope road and derive an expression for overturning speed of a vehicle.

(OR)

b) A car weighing 21336.75 N has a static weight distribution on the axles of 50:50. The wheel base is 3m and the height of CG above the ground is 0.55m. If the coefficient of friction on the highway is 0.6, calculate the advantage of having rear wheel drive rather than front wheel drive as far as gradability is concerned, if engine power is not a limitation.

23. a) Explain in detail the close coupled system to determine natural frequency and the mode shape.

(OR)

b) (i) Discuss in detail orthogonality of mode shapes. (7)

(ii) Discuss in detail modal analysis. (7)

24. a) Explain in detail choice of suspension spring rate and prove that natural frequency is proportional to square root of "L/M"; L- Load, M- Unladen sprung mass weight.

(OR)

b) A passenger car has a weight of 20.105 KN and a wheel base of 3.2 m. The weight distribution on the front axle is 53.5% and that on the rear axle is 46.5% under static conditions. (i) If the cornering stiffness of each of the front tires is 38.92 kN/rad, determine whether the vehicle is having oversteer or understeer handling characteristics and the corresponding critical or characteristic speed of the vehicle. (ii) If the tires are replaced by a pair of radial tires, each of which has a cornering stiffness of 47.82 kN/rad, and the rear tires remain unchanged, determine whether the vehicle is having oversteer or understeer handling characteristics and the corresponding critical or characteristic speed of the vehicle in m/s.

25. a) Explain in detail Rayleigh's upper bound approximation method to determine the fundamental frequency of a system.

(OR)

b) Explain in detail Holzer method for branched system to determine the natural frequency and mode shapes.

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