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AUE-701

VEHICLE DYNAMICS

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. 10×1 = 10

(i) Acceleration developed (maximum) by a vehicle is of

(A) front wheel drive (B) rear wheel drive
(C) all wheel drive (D) none of these

(ii) A vehicle is moving at uniform velocity, the reaction at the rear wheels is given by

(A) Wl/b (B) W(b – l)/b
(C) Wb/(b – l) (D) Wb(b – l)

(Where W = vehicle weight, b = wheel base, l = distance of CG from rear axle)

(iii) A disc is spinning with an angular velocity ω rad/s about the axis of spin. The couple applied to the disc causing precession will be

(A) $\frac{1}{2} I.\omega^2$ (B) $I\omega^2$
(C) $\frac{1}{2} I.\omega.\omega_p$ (D) $I.\omega.\omega_p$

where I = Mass moment of inertia of the disc and ω_p = Angular velocity of precession of the axis of spin

(iv) A vehicle will start sliding on a longitudinally inclined road when

(A) $\tan\theta < \mu$ (B) $\tan\theta > \mu$
(C) $\tan\theta < (1/\mu)$ (D) $\tan\theta > (1/\mu)$

(v) Draw bar pull may be regarded as

(A) Tractive effort – Road resistance
(B) Tractive effort + Road resistance
(C) Tractive effort + (1/Road resistance)
(D) Tractive effort – (1/Road resistance)

(vi) A vehicle will overturn in a curved path when velocity of the vehicle is given by

(A) $V_0 = (\mu\ g\ R)^{0.5}$ (B) $V_0 = (g\ R\ a/2h)^{0.5}$
(C) $V_0 = (2h/g\ R\ a)^{0.5}$ (D) $V_0 = 2h\ (1/g\ R\ a)^{0.5}$

(vii) A vehicle is moving in under-steer condition, when

(A) front slip angle > rear slip angle
(B) front slip angle < rear slip angle
(C) front slip angle = rear slip angle ≠ 0
(D) front slip angle = rear slip angle = 0

(viii) A vehicle is travelling on level ground. The reaction at the front wheel is given by

(A) w(b – l)/b (B) wb/(b – l)
(C) wb/l (D) wl/b

(ix) Lateral forces developed in a vehicle depends on

(A) velocity only (B) position of C.G. and wheel base
(C) velocity and radius of curvature (D) both (B) and (C)

(x) The co-efficient of rolling resistance for a truck weighing 63,500 N is 0.018.The rolling resistance to the truck is

(A) 1.143 N (B) 11.43 N
(C) 114.3 N (D) 1143 N

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GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. A vehicle is moving up the gradient. Obtain the condition of overturning the vehicle. 5

3. Distinguish between fore load and aft load on vehicle with neat sketch. 5

4. Obtain the expression of the skidding and overturning of the vehicle, when vehicle is taking left turn on level ground. 5

5. Obtain the expression of suspension load when a vehicle is suddenly accelerated. 5

6. Explain wheel wobble and bounce. Discuss the reasons and remedial measures of wheel wobble and bounce. 2+3

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Rolling resistance of a vehicle of mass 7,000 kg on level road is given by: 10

$$R_r = 0.0112\ mg + 0.00006\ mg\ V + 0.02688AV^2;$$

Where 'm' is mass in kg; 'V' is speed in km/hr and 'A' is the frontal area of the vehicle in m^2. The transmission efficiency in top gear of 6.2:1 is 90 % and in second gear of 15:1 is 80%. The frontal area is 6 m^2, for the maximum speed of 90 km/hr in top gear. Calculate: (i) the demand horsepower (ii) the engine speed if the driving wheels have an effective diameter 0.82 m (iii) The maximum grade the vehicle can negotiate at the above engine speed (iv) the maximum draw bar pull available on level road at the above engine speed.

(b) What are the different types of resistance forces faced when vehicle is moving on gradient? Explain their effects on the vehicle. 5

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8. (a) A rear wheel driven car having wheelbase 2.5 m. C.G. of the vehicle is 0.8 m from ground level. Plot a graph showing the variation of C.G. distance from rear axle against acceleration of the vehicle, when co-efficient of friction between tyre and road is 0.4. The C.G. distance from rear axle may be taken as a 1 m; 1.25 m; 1.4m; 1.5 m; 1.65 m; 1.7m. If required assume any data.

(b) When a vehicle is moving on a lateral inclined road, obtain the overturning and sliding velocity for taking right turn.

9. Drum brake system of a vehicle is provided with leading and trailing shoes. The inner diameter of the brake drum is 250mm. The shoes are pivoted 185cm away from the centre line of wheel cylinder and the shoe pivot is 95 mm from the drum centre. The shoes are assembled in symmetrical fashion. There are two such brake assembles on rear axles. The maximum braking torque allowed is 660 N-m on the axle. Calculate the maximum actuating force require to operate two pistons of wheel cylinders. Assume frictional force between the brake drum and shoe is 0.4.

10.(a) A vehicle is provided with disc brakes at its front and drum brakes at the rear wheels. Cross-section area of each piston on the front is 1600 mm^2 and those on the rear are 450mm^2. Area of master cylinder piston is 620 mm^2. The brake pedal is designed to have a leverage of 6 and is pressed through 45mm with an effort of 520 N. Determine (i) the ratio of braking force between front and rear axles, (ii) total force magnification, (iii) pressure intensity in brake pipe lines and (iv) movement of the wheel cylinder piston.

(b) Explain slip angle and cornering stiffness of a vehicle.

(c) Discuss the effect of slip angle in terms of the movement of any vehicle.

11.(a) Discuss the effect of the gyroscopic couple and centrifugal couple on a two wheeled bike when it is taking a turn.

(b) Find the angle of inclination with respect to the vertical of a two-wheeler negotiating a turn. Given: combined mass of the vehicle with its rider 250 kg; moment of inertia of the engine flywheel 0.3 kg-m^2; moment of inertia of each road wheel 1 kg-m^2; speed of the engine flywheel 5 times that of road wheel and in the same direction; height of the centre of gravity of rider with vehicle 0.6 m; two wheeler speed 90 km/hr; wheel radius 300mm; radius of turn 50 m.

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