Enrollment No......................................

Faculty of Engineering
End Sem Examination May-2023
AU3CO15 Vehicle Dynamics

Programme: B.Tech.　　　　　　Branch/Specialisation: AU

Duration: 3 Hrs.　　　　　　　　　　　　　**Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1　i.　Coefficient of friction is-　　　　　　　　　　　　　　　　　1
　　　　　(a) Friction force acting when body is in motion
　　　　　(b) Ratio of limiting friction to normal friction
　　　　　(c) Friction force acting when body is just about to move
　　　　　(d) None of these

　　　ii.　What must change when a body is accelerating?　　　　　　1
　　　　　(a) Mass of body　　　　　　　(b) Speed of body
　　　　　(c) Force acting on body　　　　(d) Velocity of body

　　　iii.　What is the purpose of tyre rotation on automobiles?　　　1
　　　　　(a) Avoid ply separation　　　　(b) Get better ride
　　　　　(c) Equalize wear　　　　　　　(d) Reduce bump

　　　iv.　Where will an overinflated tyre wear the thread most?　　　1
　　　　　(a) Near the center　　　　　　(b) Near the edge
　　　　　(c) In the cross direction　　　　(d) In the lateral direction

　　　v.　The weight or pressure required to deflect a spring in mm is called as-　1
　　　　　(a) Weight　　(b) Deflection　(c) Rebound　(d) Rate

　　　vi.　Squat phenomena takes place during-　　　　　　　　　　1
　　　　　(a) Hard acceleration　　　　　(b) Hard braking
　　　　　(c) Wheel spin　　　　　　　　(d) None of these

　　　vii.　In quasi-static rollover of suspended vehicle, following deflections are　1
　　　　　considered-
　　　　　(a) Tyre deflection　　　　　　(b) Suspension deflection
　　　　　(c) Both (a) & (b)　　　　　　(d) None of these

P.T.O.

viii. Tripped rollover is caused by- **1**
(a) Travelling at high speed on curved road
(b) Vehicle hitting an obstacle
(c) Losing Control due to rapid decrease in friction
(d) None of these

ix. If center of gravity of motorcycle is kept forward, the motorcycle tends **1**
to-
(a) Over-steer   (b) Under-steer
(c) Lift in acceleration   (d) Lift in braking

x. The drag force and lift force in a motorcycle are applied at point **1**
known as-
(a) Center of gravity   (b) Pressure center
(c) Moment of inertia   (d) None of these

Q.2   i.   Define vehicle dynamics as per SAE. **2**

ii.   Define the following terms: **3**
(a) Traction   (b) Braking
(c) Rolling resistance

iii.   Draw & derive the equation for normal load distribution during **5**
braking when the vehicle is on inclined path.

OR   iv.   For a tractor-semitrailer combination, the tractor weighs 66.72 kN **5**
(15,000 lb) and the semitrailer weighs 266.88 kN (60,000 lb). The
wheelbase of the tractor is 381 cm (150 in.), and the trailer axle is
1016 cm (400 in.) behind the rear axle of the tractor. The hitch point is
25 cm (10 in.) in front of the tractor rear axle and 122 cm (48 in.)
above the ground level. The center of gravity of the tractor is 203.2 cm
(80 in.) behind the tractor front axle and 96.5 cm (38 in.) above the
ground. The center of gravity of the semitrailer is 508 cm (200 in.) in
front of the trailer axle and 177.8 cm (70 in.) above the ground. What
is the ideal braking effort distribution between the axles that ensures all
the tyres being locked up at the same time on a surface with a
coefficient of road adhesion $p = 0.6$? Also calculate the normal loads
on the axles.

Q.3   i.   Write any four mechanical properties of rubber. **2**

ii.   Draw and explain tyre axis system in detail. **8**

OR   iii.   Explain the construction of pneumatic tyre in detail with sketch. **8**

Q.4   i.   What is meant by independent suspension? Compare independent **3**
suspension with conventional suspension.

ii.   What is Anti Squat suspension? Explain geometry of Anti Squat **7**
suspension with sketch.

OR   iii.   What is meant by wheel hop? Why does it happen? What are the ways **7**
to reduce the wheel hop?

Q.5   i.   What is meant by rollover? What are the causes of rollover? **4**

ii.   Explain Quasi-Static rollover of a suspended vehicle in detail with **6**
sketch.

OR   iii.   Explain transient rollover of a rigid vehicle in detail with sketch. **6**

Q.6   Attempt any two:

i.   Define trail. Write the importance of trail in motorcycle. **5**

ii.   Explain resistance force acting on a moving motorcycle with sketch. **5**

iii.   Explain in detail the effect of moment of inertia on the motorcycle with **5**
sketch.

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Marking Scheme
AU3CO15 (T) Vehicle Dynamics

Q.1 i)   Coefficient of friction is: 1
           b) Ratio of limiting friction to normal friction
     ii)   What must change when a body is accelerating?   1
           d) Velocity of body
     iii) What is the purpose of tire rotation on automobiles?   1
           c) Equalize wear
     iv)   Where will an overinflated tire wear the thread most?   1
           a) Near the Center
     v)   The weight or pressure required to deflect a spring in mm is called   1
           as:
           d) Rate
     vi)   Squat phenomena takes place during: 1
           a) Hard Acceleration
     vii) In quasi-static rollover of suspended vehicle, following   1
           deflections are considered:
           c) Both a & b
     viii) Tripped rollover is caused by: 1
           b) Vehicle hitting an obstacle
     ix)   If center of gravity of motorcycle is kept forward, the motorcycle   1
           tends to:
           a) Over-Steer
     x)   The drag force and lift force in a motorcycle are applied at point   1
           known as:
           b) Pressure Center

Q.2 i.   Define Vehicle Dynamics as per SAE.
           Definition   -2 Marks
     ii.   Define i) Traction ii) Braking iii) Rolling resistance.

           Traction   -1 Mark
           Braking   -1 Mark
           Rolling Resistance   -1 Mark
     iii.
           Draw & derive the equation for normal load distribution during
           braking when the vehicle is on inclined path.
           Derivation   -4 Marks
           Sketch   -1 Mark

OR   iv.   For a tractor-semitrailer combination, the tractor weighs 66.72 kN
           (15,000 lb) and the semitrailer weighs 266.88 kN (60,000 lb). The
           wheelbase of the tractor is 381 cm (150 in.), and the trailer axle is
           1016 cm (400 in.) behind the rear axle of the tractor. The hitch
           point is 25 cm (10 in.) in front of the tractor rear axle and 122 cm
           (48 in.) above the ground level. The center of gravity of the tractor
           is 203.2 cm (80 in.) behind the tractor front axle and 96.5 cm (38
           in.) above the ground. The center of gravity of the semitrailer is
           508 cm (200 in.) in front of the trailer axle and 177.8 cm (70 in.)
           above the ground. What is the ideal braking effort distribution
           between the axles that ensures all the tires being locked up at the
           same time on a surface with a coefficient of road adhesion p =
           0.6? Also calculate the normal loads on the axles.
           Solve either in kN or lb
           Draw Free Body Diagram (FBD)
           FBD of tractor   -0.5 Mark
           FBD of trailer   -0.5 Mark
           FBD of tractor-trailer   -0.5 Mark
           Breaking effort distribution:
           F_{bf}: 5370.73 lb (Breaking effort on front axle of tractor) -0.5 Mark
           F_{br}: 21190.25 lb (Breaking effort on rear axle of tractor) -0.5 Mark
           F_{bs}: 18439.02 lb(Breaking effort on axle of semi-trailer) -0.5 Mark
           Normal Loads on axle:
           For Semi-Trailer:
           W_{hi}=29268.3 lb (Load on hitch point)   -0.5 Mark
           W_s=30731.7 lb (Load on semi-trailer axle)   -0.5 Mark
           For Tractor:
           W_r=35317.08 lb (Load on rear axle)   -0.5 Mark
           W_f= 8951.22 lb (Load on front axle)   -0.5 Mark

Q.3 i.   Write any four mechanical properties of rubber.
           Any four properties   -4*0.5=2 Marks
     ii.   Draw and explain tyre axis system in detail.
           Sketch   -2 Marks
           Explanation   -6 Marks
OR   iii. Explain the construction of pneumatic tyre in detail with sketch.
           Explanation   -5 Marks
           Sketch   -3 Marks

Q.4 i.   What is meant by independent suspension? Compare independent
           suspension with conventional suspension.
           Independent Suspension   -1 Mark

Comparison with conventional suspension   -2 Marks
ii.   What is Anti Squat suspension? Explain geometry of Anti Squat suspension with sketch.
      Anti-Squat suspension   -2 Marks
      Geometry of anti-squat suspension   -3 Marks
      Sketch   -2 Marks
OR iii. What is meant by wheel hop? Why does it happen? What are the ways to reduce the wheel hop?
      Wheel Hop   -2 Marks
      Why does it happen   -3 Marks
      Ways to reduce wheel hop   -3 Marks

Q.5   i.   What is meant by rollover? What are the causes of rollover?
      Rollover meaning   -2 Marks
      Consequences of rollover   -2 Marks
      ii.   Explain Quasi-Static rollover of a suspended vehicle in detail with sketch.
      Explanation   -4 Marks
      Sketch   -2 Marks
OR iii. Explain Transient Rollover of a rigid vehicle in detail with sketch.
      Explanation   -4 Marks
      Sketch   -2 Marks

Q.6   Attempt any two:
      i.   Define trail. Write the importance of trail in motorcycle.
      Definition   -2 Marks
      Importance of trail   -3 Marks
      ii.   Explain resistance force acting on a moving motorcycle with sketch.
      Explanation   -3 Marks
      Sketch   -2 Marks
      iii. Explain in detail the effect of moment of inertia on the motorcycle with sketch.
      Explanation   -3 Marks
      Sketch   -2 Marks

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