

Indian Institute of Technology Delhi
Department of Mechanical Engineering

Major test (4/5/2023)

MCL321- Automotive Systems

Time: 2 hours

Max. Marks: 60

Instructions: Please attempt all three questions. Marks of each questions are indicated with associated RHS. Use scale, pencil and other drawing instruments in preparing the sketches/diagrams.

- Q.1 (a) What are lubricants and lubrication? What are three conditions needed for separation of two mating surfaces by lubricating film? (Marks: 2+3)
(b) Write any five properties of lubricants required in automotive lubrication. What is viscosity index? (Marks: 2.5+2.5)
(c) How density and viscosity of lubricating oil varies with pressure and temperature? (Marks: 2)
(d) Explain the followings: (Marks: 1+1+1)
(i) Mineral oil; (ii) Multigrade oil; (iii) Synthetic oil

- Q.2 (a) Sketch front axle of an automotive vehicle and show how it is connected with the stub axle. (Marks: 3+2)
(b) Explain the followings- (Marks: 1+1+1+2)
(i) What is leaf spring? (ii) Explain the shot peening? ; (iii) Why shot peening is done? ;
(iv) Nip and nipping in leaf spring

- (c) In the context of leaf springs, derive the following stress relations for full and graduated leaves: (Marks: 10)

$$(\sigma_b)_g = \frac{12PL}{(3n_f + 2n_g) bt^2}$$

$$(\sigma_b)_f = \frac{18PL}{(3n_f + 2n_g) bt^2}$$

Where, n_f = number of extra full-length leaves, n_g = number of graduated-length leaves including master leaf, n = total number of leaves, b = width of each leaf (mm), t = thickness of each leaf (mm), L = length of the cantilever or half the length of semi-elliptic spring (mm), P = force applied at the end of the spring (N), P_f = portion of P taken by the extra full-length leaves (N), P_g = portion of P taken by the graduated-length leaves (N)

- (d) A semi-elliptic spring used for automobile suspension, consists of two extra full-length leaves and eight graduated-length leaves, including the master leaf. The centre-to centre distance between the two eyes is 1 m. The leaves are made of steel ($S_y = 1500$ MPa, $E = 207$ GPa) and the factor of safety is 1.5. The maximum spring load is 50 kN. The leaves are pre-stressed so as to equalize stresses in all leaves under maximum load. Determine the dimensions of the cross-section of the leaves and the deflection at the end of the spring. The ratio between width and thick of all leaves are 6. (Marks: 8)

- Q.3 (a) Describe in detail a universal joint used in automobiles. (Marks: 3)
(b) Sketch neatly a differential gear system and explain its functioning. (Marks: 4+3)
(c) What is suspension system? Why it is important in the vehicle system? (Marks: 2+2)
(d) What do you understand by pitching, rolling and yawing of a vehicle? Explain. (Marks: 3)

60 + 15 + 12
A/R