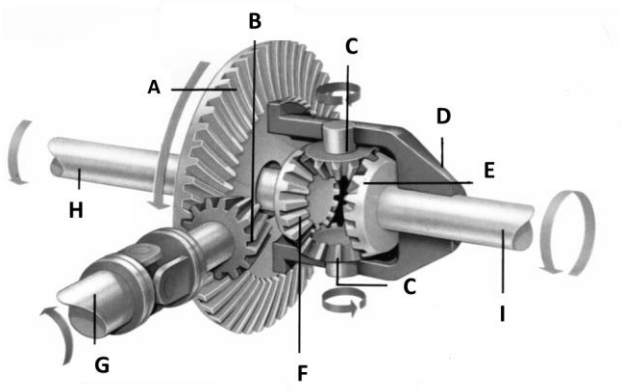
Birla Institute of Technology and Science, Pilani
Semester-I (2022-2023)
ME F484: Automotive Technology
(Mid-sem Exam**, Closed Book**)

Full Marks – 60, Weightage – 30% Time - 90 minutes, 02nd Nov. 2022

Instructions:
All questions are compulsory.
Wherever required draw neat sketch.
Take suitable assumption, if required. However, it should be stated clearly.

1. What do you mean by the camber angle? What are its various types? How the camber angle can affect vehicle handling and maneuverability during cornering? Explain. [10]

2. Name the various components of a differential shown in the figure. Explain the working principle of the differential mechanism. What is the difference between an open differential and a limited slip differential? [10]



3. A six-cylinder, 4-stroke SI engine having a piston displacement of 700 cm^3 per cylinder developed 78 kW at 3200 r.p.m. and consumed 27 kg of petrol per hour. The calorific value of petrol is 44 MJ/kg. Estimate: (i) The volumetric efficiency of the engine if the air-fuel ratio is 12 and intake air is at 0.9 bar, 32°C. (ii) The brake thermal efficiency, and (iii) The brake torque. [12]

4. A simple jet carburetor is required to supply 6 kg of air per minute and 0.45 kg of fuel of density 740 kg/m3. The air is initially at 1.013 bar and 27°C. If the air flow velocity is 92 m/s at the throat and velocity coefficient = 0.8. Calculate (i) suction pressure at the throat and (ii) the throat diameter of the choke. (ii) If the pressure drop across the fuel metering orifice is 0.75 of that at the throat, calculate the orifice diameter assuming Cd = 0.60. [14]

5. An engine producing 110kW at 5000 rpm drives a four-wheeled vehicle (rear wheel drive) weighing 1.4 tones. The weight of the vehicle is equally distributed between all the wheels. Engine is connected to a transmission with gear ratios of 4.2, 3.5, 2.1, and 1 and the axle ratio of final drive is 5:1. The vehicle is taking a turn in the first gear on a road having friction coefficient of 0.5. During turning, the outer wheel rotates at 300 rpm. Calculate (i) the power available at both the wheels, (ii) the rolling radius of the rear wheels. (iii) If the vehicle was stuck with one of the rear wheel in a mud with limiting frictional coefficient of 0.2, estimate the torque transmitted to each rear wheels. [14]

Formulas:

For air, R = 0.287 kJ/kgK, and $\gamma = 1.4$

For Dual cycle,

$$\eta_{Dual} = 1 - \frac{1}{r^{(\gamma-1)}}\left[\frac{r_p r_c^{\gamma} - 1}{(r_p - 1) + r_p\gamma(r_c - 1)}\right]$$

$$p_m = p_1 \frac{[\gamma r_p r^{\gamma}(r_c - 1) + r^{\gamma}(r_p - 1) - r(r_p r_c^{\gamma} - 1)]}{(\gamma - 1)(r - 1)} \quad 1)]$$

With cut-off ratio r_c = 1, it becomes an Otto cycle, and with pressure ratio r_p = 1, it becomes a Diesel cycle, r is the compression ratio

$$C_2 = C_d\sqrt{2C_pT_1\left[1 - \left(\frac{p_2}{p_1}\right)^{\left(\frac{\gamma-1}{\gamma}\right)}\right]}$$

$$C_f = \sqrt{2\left[\frac{p_1 - p_2}{\rho_f} - gz\right]}$$

$$\dot{m}_a = \frac{A_2 p_1}{R\sqrt{T_1}}\sqrt{2C_p\left[\left(\frac{p_2}{p_1}\right)^{\frac{2}{\gamma}} - \left(\frac{p_2}{p_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

$$\dot{m}_{a_{actual}} = C_{da}A_2\sqrt{2\rho_a(p_1 - p_2)}$$

$$\dot{m}_f = A_f C_f\sqrt{2\rho_f \Delta p_f}$$

All the symbols have their usual meanings.