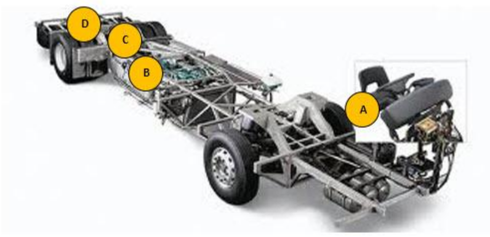
	Final Assessment Test – Winter 2024-25 Semester - Apr 2025	
	Course code : BMEE414L	Slot : A2 + TA2
	Course Title : Vehicle Body and Aerodynamics Engineering	Time: **Three Hours**
	Class Number(s) : VL2024250503868	Max. Marks: **100**
	Faculty Name : Dr. Y. Mukkamala	School: SMEC
	Emp Id : yagnasmukkamala@vit.ac.in	Mobile No.: 9345310732

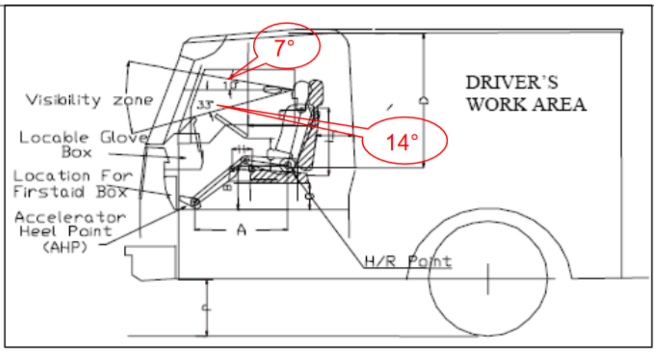
KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

General Instructions if any:

1. **Non Programmable calculator is permitted : YES /NO**
2. **Reference tables are permitted : YES / NO (if Yes, Please specify:)**

Answer ALL Questions
(10 X 10 = 100 Marks)

Sl. No:	**Questions**	**Module No**	**Marks**	**CO**	**BL**	**E/A/T**
1.	Bus chassis: Ladder frame  Tubular space-frame:  Driver seat and visibility:	1	**10**	**1**	**3**	**T**

<table>
<tr>
<td></td>
<td>

Dimensional Requirements:
A Distance from Heel Point to “H” Point 600 mm to 640 mm
B Minimum Distance from floor to “H” Point with the driver’s seat in the upper most position
500 mm
C Thigh Clearance 200 mm to 260 mm
D Minimum Distance from “H” Point to Roof top 1060 mm
E Minimum Distance from the lower end of steering to the front of driver’s seat back rest 350 mm
F Minimum Distance of driver’s partition from the rear of the driver’s seat with the driver’s seat in the rear most
Position 25 mm
Windshield: A clean and clear windshield is essential for optimal visibility
Mirror adjustment: Properly adjusted side and rearview mirrors are crucial for monitoring blind spots
Bus design: The design of the bus, including the size and placement of windows, can affect the driver's field of view
(Source: ARAI) </td>
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<td>2.</td>
<td>a. Visibility tests conducted in certified labs.
b. Photometry: Measurement of light from headlamps to check for adequate lighting. Both high and low beams are tested.
c. Camera fixed at driver’s head location in the front seat.
i. A complete 360° sweep indicates how much is visible through windshields and side windows.
ii. Obstruction by A, B, and C pillars, roof, headrests, antennas, wipers, and other attachments is assessed.</td>
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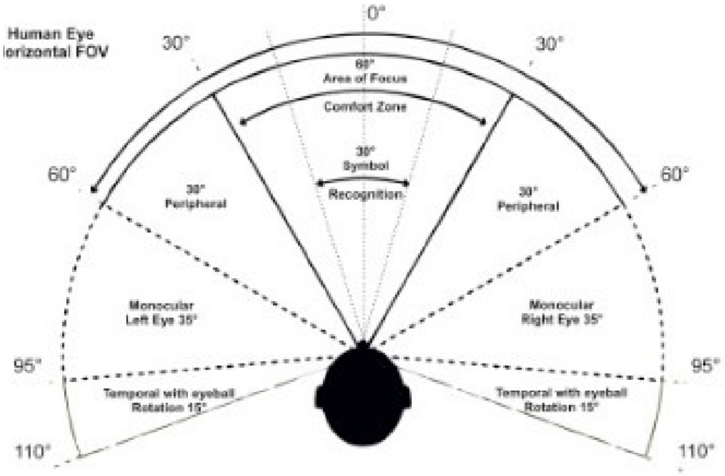
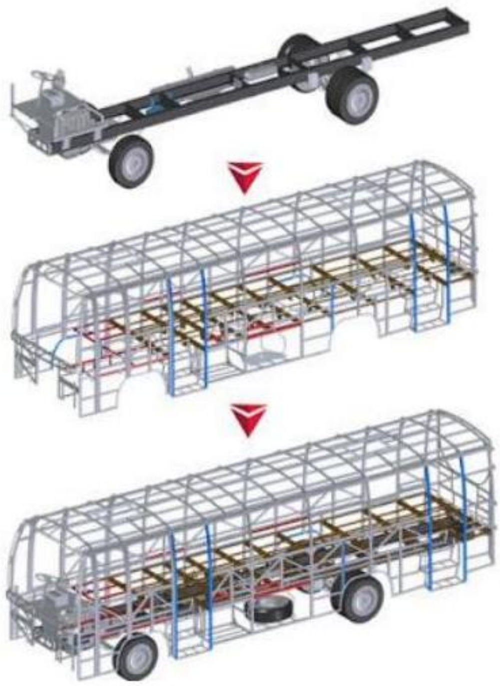
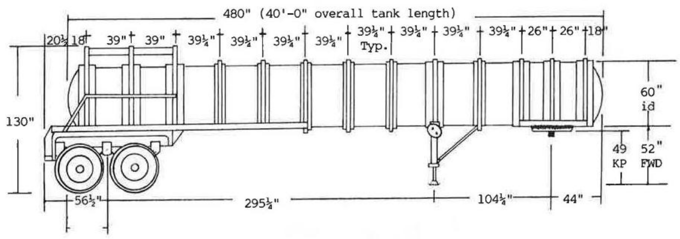
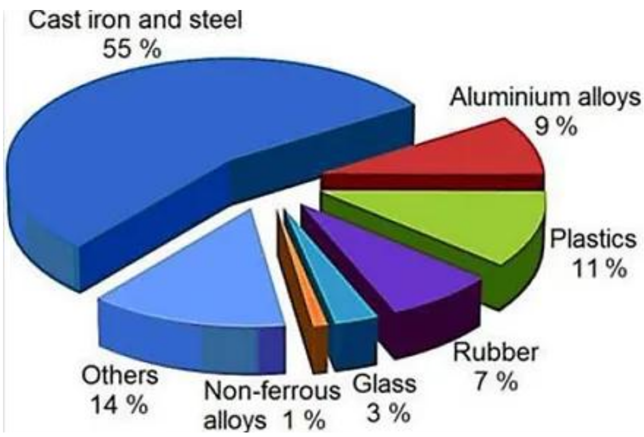
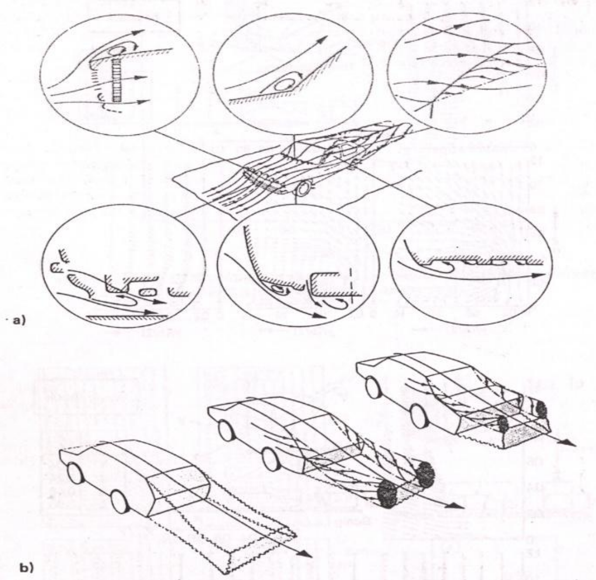
	iii. LOS for down viewing tested to see if low objects on the road can be detected. iv. Detected views in side and rearview mirrors, swept area of windshields, headlamp beam pattern/length/coverage area checked. v. The H-point (torso and thigh joint at the hip) of the driver should be located. Optimized with the seat recline angle for clear LOS.  					
3.	Ladder frame chassis – conventional bus fabrication: 	2	**10**	**2**	**3**	**T**

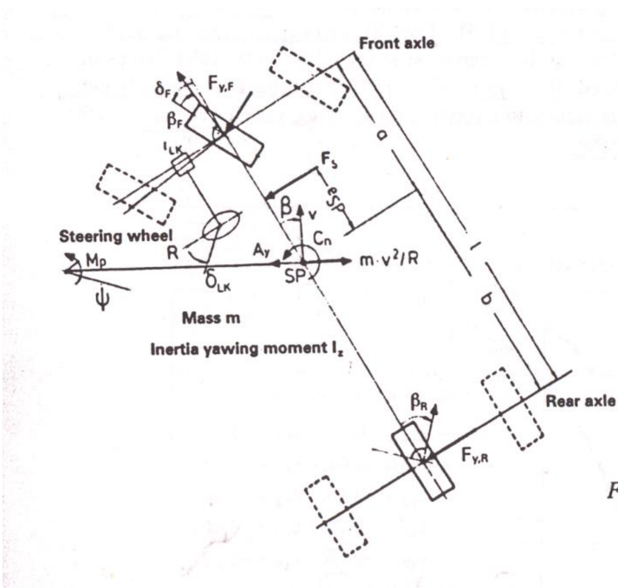
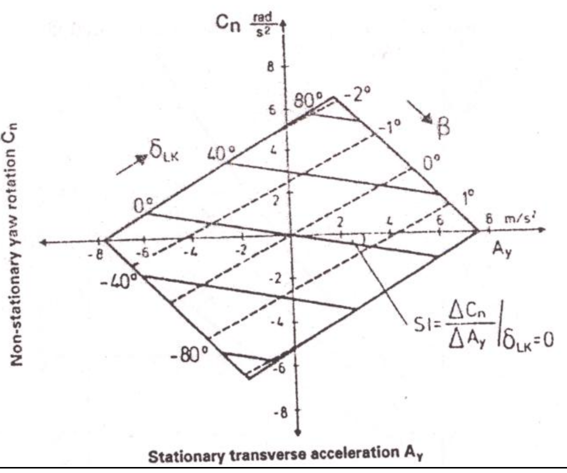
	 • Chassis and body developed separately • Chassis and bus body are bolted, riveted, and welded for joining • Rubber blocks inserted between chassis and body for vibration isolation • Channel, tubular, and solid sections used • Underbody from thin, cold rolled steel sheets • Fully galvanized for corrosion resistance • Sheet steel for roof • Outer panels and roof truss are riveted • Used for heavy trucks and buses					

4.	Tanker body:
	
	
	• FRP (fiberglass reinforced plastic), SS, and Aluminum shells
	• Typical design:
	  • Volume: 5683 gallons
	  • Tank: 60” I.D, 40’ long
		3	**10**	**2**	**4**	**T**

	• Hemispherical ends; 48” crown radius • Designed to carry liquids and gases • Oval and cylindrical tank trailers reduce internal stress • **High C.G; more prone to rollover** • **Liquid sloshing in partially filled tanks** • Volume: 5500-11,600 gallons • Tanks have baffles and multiple compartments inside • Ideal for milk, gasoline, diesel, LPG, oils, etc.					
5.	Aluminum contributes to 9% of overall body materials:  Sheet aluminum contributes to 30-60% weight reduction. • Ductile, malleable, tensile, recyclable • Lighter than steel, same strength • Rust resistant • Corrosion resistant (but not as good as SS) • Special welding and machining needed • Bends under loads easily • More expensive than steel. Energy intensive extraction • Alloys: Cold rolled Al-Si, Al-Mg, Al-Mn, Al-Si-Mg, Al-Zn-Mg alloys	4	**10**	**2**	**4**	**T**
6.	Flowfield around a car:	5	**10**	**3**	**4**	**T**

	134 *Aerodynamics of Road Vehicles*  *Fig. 4.3 Airflow around a car and the main flow separations: a) on the front-end structure, b) on the three types of car back.* Impact of drag on tractive force: $$F_T - R - mg\sin\theta - D = m\frac{dV}{dt}$$ Total fuel consumption for power driving (overcoming drag): $$B[L/100km] = C\frac{\frac{1}{\rho fuel}\int_{F_T>0}[\dot{b}_{sfc}P_{b,T}dt + \dot{b}sfc\,P_{b,A}] + \int_{F_T<0}\dot{b}_b\,dt + \int_{F_T=0}\dot{b}_{idle}\,dt}{\int_0^t V dt}$$					
7.	Rear diffuser: A rear diffuser is a device that shapes the airflow under the rear of the car. It creates a low-pressure zone behind the car, which reduces drag and lift Smoother underbody: A smooth underbody reduces drag by smoothing the passage of air under the car. Fit a full smooth under tray, including covering the exhaust. Reduce the size of tire wakes Suck turbulent air inboard Eject turbulent air up and over the car behind Increase the width of the tires	5	**10**	**3**	**4**	**T**

8.	a. Monopole : A monopole source models the intensity of sound as being proportional to the fourth power of the velocity. $I \sim V^4$. Monopoles are produced due to transient or oscillating flows. Ex : Oscillating flow in the engine intake and exhaust ducts. If a exterior pressure fluctuation on the vehicle causes an interior volumetric air pocket from the vehicle to leak, that would constitute a secondary monopole. b. Dipole : Dipoles are formed due to the interaction between exterior flows, and the chassis. Ex : A fluctuating pressure on the car surface can produce a dipole type noise which will be $\sim V^6$. c. Quadrupoles : Quadrupoles are produced by the interaction between two fluid elements. The intensity of sound produced by such sources is weak, and is $\sim V^8$. Since $I_{quadrupole}/I_{dipole} \sim M^2$, quadrupoles can be neglected in comparison to dipoles, which are always present. To measure wind noise on a car using microphones, one typically mount specialized microphones on the exterior of the vehicle, often in strategic locations like the door mirrors or windshield frame, to capture the air pressure fluctuations caused by wind while the car is moving, allowing analysis of the noise spectrum and identification of areas where wind noise is most prominent; this process usually involves using specialized microphones with windshields and employing data analysis techniques to isolate the wind noise from other vehicle sounds. A high-quality microphone with a suitable preamplifier is needed to capture the sound accurately. The microphone is strategically placed within the car cabin, often near the driver's ear position, to best represent the perceived noise level. **On-road testing:** Driving at various speeds on a controlled road to assess real-world wind noise.	6	**10**	**4**	**5**	**T**

	• • **Wind tunnel testing:** Considered the most accurate method, as it allows for controlled wind conditions and isolation from other noise sources. **Sound pressure level (dB):** The measured wind noise is typically expressed in decibels (dB). • • **Frequency spectrum:** Analyzing the frequency components of the noise can help identify specific sources of wind noise. (Source: Swamy Mukkera, Senthilkumar Raamya Premkumar, Deshpande Samar, Prasath R, "A Test Methodology for Vehicle Wind Noise Reduction and Acoustic Quality Improvement", SAE International, article no.: 2019-26-0216).					
9.	**A)**  	6 6	**10** **10**	**4** **4**	**5** **5**	**T** **T**

$$\dot{\psi} = I_F . F_{SF} - I_R F_{SR} + e_{SP} \frac{Y}{I_Z}$$

$$A_Y = \frac{F_{SF} + F_{SR} + Y}{m}$$

- **For a straight driving, $\delta_{LK} = 0$, the SI is**

$$\left.\frac{\Delta C_N}{\Delta A_Y}\right|_{\delta_{LK}=0}$$

- A higher negative stability index would yield more stability.
- Driving stability generally decreases for speeds more than 150 kmph (94 mph).
- Stability can however be improved by attaching flow spoilers like fins, or negative delta wings.
- Rear end additions reduce lift force on rear axle, but increase drag.
- However, if the side wind angle is less than the critical yaw angle, the increase in fuel consumption due to higher drag, is negligible.

(OR)

B)

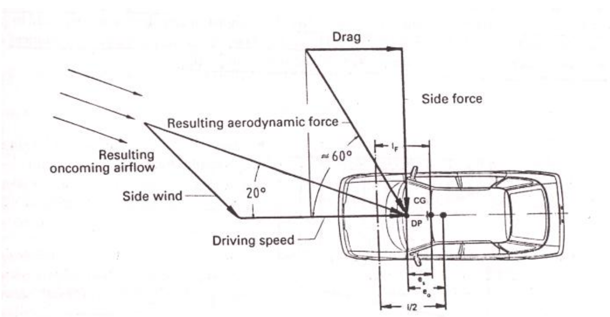
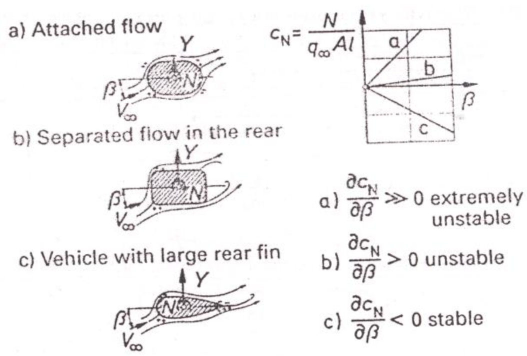
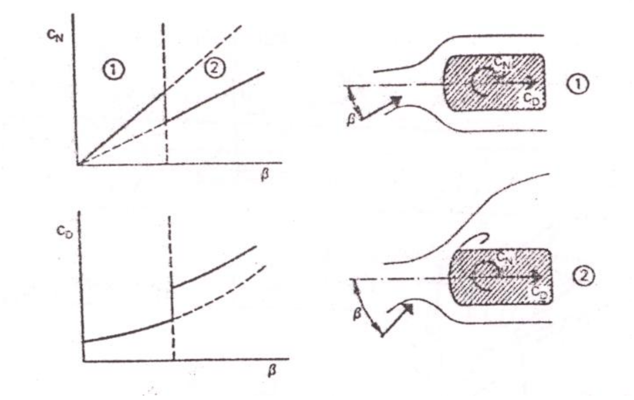
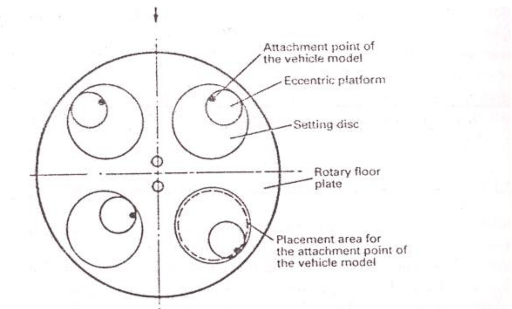
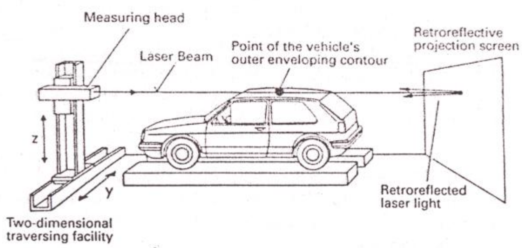


Fig. 5.6 Resulting forces and moments under yawed flow.



						
10.	**A)**  *Fig. 14.4 Wheelbase and tread-width adjusting possibility using eccentric plates, after K.B. Kelly, et al. [14.3].* **(OR)** **B)**  *Fig. 14.5 Measurement of the frontal area by laser technology, after M.-A. Beeck and B. Stoffregen [14.4].*	7 7	**10** **10**	**5** **5**	**5** **5**	**T** **T**
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M.S. Yognavalkya

March 6, 2025

Signature with date