

031

**MASS & BALANCE**

**AIRLINE TRANSPORT PILOTS LICENCE (A)  
(FLIGHT PERFORMANCE AND PLANNING)**

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
030 00 00 00	<b><u>FLIGHT PERFORMANCE AND PLANNING</u></b>	
031 00 00 00	<b><u>MASS AND BALANCE</u></b>	
031 01 00 00	<b><u>INTRODUCTION TO MASS AND BALANCE</u></b>	
031 01 01 00	<b><u>Centre of Gravity</u></b>	
031 01 01 01	<b>Definition</b>  – Define the centre of gravity related to an aeroplane	
031 01 01 02	<b>Importance for aircraft stability</b>  – Explain why the C.G. must be within the certified limits with regard to aeroplane operations	
031 01 02 00	<b><u>Mass and Balance limits</u></b>	
031 01 02 01	<b>Consult aeroplane flight manual:</b>  – Describe the effects of operating an aeroplane at its mass and centre of gravity limits – Find the certified centre of gravity limits for takeoff, landing and cruise configuration from the aeroplane operating manual AOM	
031 01 02 02	<b>Maximum floor load</b>  – State that maximum floor/running loads have to be considered when loading small heavy items. – Calculate examples and extract the necessary data from an aeroplane operating manual.	
031 01 02 03	<b>Maximum ramp and taxi mass</b>  – Explain maximum ramp and taxi mass	
031 01 02 04	<b>Factors determining maximum permissible mass</b>  – Describe the limitations for the maximum permissible Takeoff and Landing mass.	

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031 01 02 05	<ul style="list-style-type: none"> <li>– Describe the limitations for the maximum traffic load.</li> <li>– Calculate examples for these masses</li> </ul> <p><b>Factors determining centre of gravity limits</b></p> <ul style="list-style-type: none"> <li>– State that centre of gravity limits are determined by aircraft stability and manoeuvrability and describe the influence on aeroplane operation</li> <li>– Summarise all factors that affect the location of the centre of gravity during aeroplane operation.</li> <li>– Describe the effect of extending/retracting flaps on the pitching moment</li> </ul>	
031 02 00 00	<b><u>LOADING</u></b>	
031 02 01 00	<b><u>Terminology</u></b>	
	<ul style="list-style-type: none"> <li>– Define take-off mass, landing mass and max. inflight mass</li> </ul>	
031 02 01 01	<b>Empty mass</b>	
	<ul style="list-style-type: none"> <li>– Define ‘empty mass’, ‘basic mass’ and ‘basic empty mass’.</li> <li>– State where these masses can be found.</li> <li>– Calculate an example for the basic empty mass</li> </ul>	
031 02 01 02	<b>Dry operating mass (empty mass + crew + operating items + unusable fuel)</b>	
	<ul style="list-style-type: none"> <li>– Define ‘dry operating mass’ and ‘operating mass’ and calculate examples</li> </ul>	
031 02 01 03	<b>Zero fuel mass</b>	
	<ul style="list-style-type: none"> <li>– Define ‘zero fuel’ and ‘maximum zero fuel mass’.</li> <li>– Describe the reason for limiting the zero fuel mass.</li> <li>– Calculate examples</li> </ul>	
031 02 01 04	<b>Standard mass</b>	

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031 02 01 05	<ul style="list-style-type: none"> <li>– State when to apply actual or standard masses for crew, passengers, baggage and cargo according to JAR-OPS1.</li> <li>– Find the standard masses for different types of flights with reference to JAR-OPS1.</li> <li>– Calculate total traffic loads and total mass of crew</li> <li>– Describe the relation between volume, density and mass for fuel, oil and water and calculate examples</li> </ul> <p><b>Useful load (Traffic load + Usable fuel)</b></p> <ul style="list-style-type: none"> <li>– Define ‘traffic load’ and ‘useful load’.</li> <li>– Calculate examples for traffic and useful load</li> </ul>	JAR-OPS1 given
031 02 02 00	<b><u>Aircraft Mass Check</u></b>	
031 02 02 01	<b>Procedure</b>	
	<ul style="list-style-type: none"> <li>– State where the results of an aircraft mass check are found.</li> <li>– State who is responsible for re-weighing and the issuing the correct dry operating mass.</li> <li>– List the practices, according to JAR-OPS1, to be used at re-weighing</li> </ul>	
031 02 02 02	<b>Requirements for re-weighing of aircraft</b>	
	<ul style="list-style-type: none"> <li>– List the time intervals for the re-weighing of aeroplanes according to JAR-OPS1</li> </ul>	
031 02 02 03	<b>Equipment lists</b>	
	<ul style="list-style-type: none"> <li>– State that the equipment list is used to name which items are included in the re-weighing process</li> </ul>	
031 02 03 00	<b><u>Procedures for determining aeroplanes mass and balance documentation</u></b>	
031 02 03 01	<b>Determining dry operating mass</b>	
	<ul style="list-style-type: none"> <li>– Aircraft mass and balance data.</li> <li>– Extract the dry operating mass DOM, dry operating index DOI for specified crew, trip and service conditions from the aeroplane operating manual AOM</li> </ul>	

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031 02 03 02	<b>Intentionally left blank</b>	
031 02 03 03	<b>Add mass of passengers and cargo</b>  – Calculate the maximum allowable traffic load, the zero fuel mass and maximum cargo loads for different conditions	
031 02 03 04	<b>Add mass of fuel</b>  – Calculate the maximum allowable fuel load, the maximum extra fuel and the useful load	
031 02 03 05	<b>Check that applicable maximum gross mass limits are not exceeded</b>  – Calculate takeoff mass, maximum takeoff mass, landing mass and maximum landing mass	
031 02 04 00	<b><u>Effects of Overloading</u></b>	
031 02 04 01	<b>Higher take-off and safety speeds</b>  – Explain the influence of the aeroplane mass on takeoff and safety speeds	
031 02 04 02	<b>Longer take-off and landing distances</b>  – Explain the influence of the aeroplane mass on takeoff and landing distances	
031 02 04 03	<b>Lower rate of climb</b>  – Explain the influence of the aeroplane mass on the rate of climb.	
031 02 04 04	<b>Influence on range and endurance</b>  – Explain the influence of the aeroplane mass on the range and endurance	
031 02 04 05	<b>Decreased engine-out performance</b>  – Explain the influence of the aeroplane mass on the one-engine out performance	
031 02 04 06	<b>Possible structural damage in extreme cases</b>  – Explain the potential risks during a landing when the aeroplane mass limits are greatly exceeded	

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031 03 00 00	<b><u>CENTRE OF GRAVITY (C.G)</u></b>	
031 03 01 00	<b><u>Basis of C.G. Calculations</u></b>	
031 03 01 01	<b>Datum</b> <ul style="list-style-type: none"> <li>– Explain the term datum.</li> <li>– Find the datum position from an aeroplane operating manual for calculation purposes.</li> </ul>	
031 03 01 02	<b>Moment arm</b> <ul style="list-style-type: none"> <li>– Explain the moment arm and its algebraic sign.</li> <li>– Extract moment arms for different loading positions from aeroplane operating manual</li> </ul>	
031 03 01 03	<b>Moment</b> <ul style="list-style-type: none"> <li>– Explain the term ‘moment’ and calculate examples.</li> <li>– Explain the term ‘index’ and interpret an example of an index formula.</li> <li>– Calculate the index with given weight, centre of gravity and index formula and vice versa</li> </ul>	
031 03 01 04	<b>Expression in percentage of mean aerodynamic chord (% MAC)</b> <ul style="list-style-type: none"> <li>– Explain the general equation for the centre of gravity.</li> <li>– Illustrate the advantage of using % MAC as an expression for the centre of gravity location.</li> <li>– Calculate centre of gravity positions and express them in % MAC</li> </ul>	
031 03 02 00	<b><u>Calculation of C.G.</u></b>	
031 03 02 01	<b>Centre of gravity at empty mass</b> <ul style="list-style-type: none"> <li>– Calculate the aeroplane centre of gravity from scale readings at weighing.</li> <li>– Find the centre of gravity at the dry operating mass from the aeroplane manual.</li> </ul>	
031 03 02 02	<b>Movement of C.G with addition of fuel, load and ballast</b>	

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031 03 02 03	<ul style="list-style-type: none"> <li>– Calculate the effect of shifting loads or additional loads on the centre of gravity.</li> <li>– Describe the influence of fuel loading or usage on the centre of gravity.</li> <li>– Extract the data for the influence of fuel on the centre of gravity from an aeroplane operating manual.</li> </ul> <p><b>Practical methods of calculation</b></p>	<p>Mass and balance documents of various Aircraft types.</p>
031 03 03 00	<ul style="list-style-type: none"> <li>– Calculate zero fuel, takeoff and landing masses, the respective moments and centre of gravity positions with the aid of various types of mass and balance documentations</li> <li>– Explain the differences between operational and certified limits for the centre of gravity.</li> <li>– State where the certified and where the operational limits can be found and extract them</li> </ul> <p><b><u>Securing of Load</u></b></p>	
031 03 03 01	<p><b>Importance of adequate tie-down</b></p> <ul style="list-style-type: none"> <li>– Describe the reasons why loads in cabin and cargo rooms have to be secured or tied down.</li> <li>– State that cargo aeroplanes use pallets or containers to secure the load</li> </ul>	
031 03 03 02	<p><b>Effect of loadshift</b></p> <ul style="list-style-type: none"> <li>– Effect of Loadshift</li> <li>– See 031 03 02 02</li> </ul>	
031 03 04 00	<p><b><u>Area Load, Running Load, Supporting</u></b></p> <ul style="list-style-type: none"> <li>– See 031 01 02 02</li> </ul>	