

031

**MASS & BALANCE**

**COMMERCIAL PILOT 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>Centre of Gravity</b>	
031 01 01 01	<b>Definition</b>  – Define the term Centre of Gravity related to an aeroplane	
031 01 01 02	<b>Importance for aircraft stability</b>  – Explain why the CG 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 heavy items with small support areas. – 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>	

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031 01 02 05	<ul style="list-style-type: none"> <li>– Describe the limitations for the maximum permissible Takeoff and Landing mass.</li> <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>	
031 02 01 01	<p><b>Empty mass</b></p> <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	<p><b>Dry Operating Mass (empty mass + crew + operating items + unusable fuel)</b></p> <ul style="list-style-type: none"> <li>– Define ‘Dry Operating Mass’ and ‘operating mass’ and calculate examples</li> </ul>	
031 02 01 03	<p><b>Zero fuel mass</b></p> <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>	

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031 02 01 04	<b>Standard mass</b> <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>	JAR-OPS1 given
031 02 01 05	<b>Useful load (Traffic load + Usable fuel)</b> <ul style="list-style-type: none"> <li>– Define ‘traffic load’ and ‘useful load’.</li> <li>– Calculate examples for traffic and useful load</li> </ul>	
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>	

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031 02 03 02	<ul style="list-style-type: none"> <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> <p><b>Intentionally left blank</b></p>	
031 02 03 03	<p><b>Add mass of passengers and cargo</b></p> <ul style="list-style-type: none"> <li>– Calculate the maximum allowable traffic load, the zero fuel mass and maximum cargo loads for different conditions</li> </ul>	
031 02 03 04	<p><b>Add mass of fuel</b></p> <ul style="list-style-type: none"> <li>– Calculate the maximum allowable fuel load, the maximum extra fuel and the useful load</li> </ul>	
031 02 03 05	<p><b>Check that applicable maximum gross mass limits are not exceeded</b></p> <ul style="list-style-type: none"> <li>– Calculate takeoff mass, maximum takeoff mass, landing mass and maximum landing mass</li> </ul>	
031 02 04 00	<b><u>Effects of Overloading</u></b>	
031 02 04 01	<p><b>Take-off and safety speeds</b></p> <ul style="list-style-type: none"> <li>– Explain the influence of the aeroplane mass on takeoff and safety speeds</li> </ul>	
031 02 04 02	<p><b>Take-off and landing distances</b></p> <ul style="list-style-type: none"> <li>– Explain the influence of the aeroplane mass on takeoff and landing distances</li> </ul>	
031 02 04 03	<p><b>Rate of climb</b></p> <ul style="list-style-type: none"> <li>– Explain the influence of the aeroplane mass on the rate of climb.</li> </ul>	
031 02 04 04	<p><b>Range and Endurance</b></p> <ul style="list-style-type: none"> <li>– Explain the influence of the aeroplane mass on the range and endurance</li> </ul>	
031 02 04 05	<b>Engine-out performance</b>	

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031 02 04 06	<ul style="list-style-type: none"> <li>– Explain the influence of the aeroplane mass on the one-engine out performance</li> </ul> <p><b>Structural strain</b></p> <ul style="list-style-type: none"> <li>– Explain the potential risks when the aeroplane mass limits are exceeded</li> </ul>	
031 03 00 00	<b><u>CENTRE OF GRAVITY (CG)</u></b>	
031 03 01 00	<b><u>Basis of CG Calculations</u></b>	
031 03 01 01	<p><b>Datum</b></p> <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	<p><b>Moment arm</b></p> <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	<p><b>Moment</b></p> <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	<p><b>Expression in percentage of mean aerodynamic chord (% MAC)</b></p> <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>	

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031 03 02 00	<b><u>Calculation of CG</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 CG with addition of fuel, load and ballast</b> <ul style="list-style-type: none"> <li>– Calculate the effect of additional loads on the Centre of Gravity.</li> <li>– Describe and calculate 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>	
031 03 02 03	<b>Practical methods of calculation</b> <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 documentation</li> <li>– Explain the differences between operational and certified limits for the Centre of Gravity.</li> <li>– State where the certified and operational limits can be found and extract them</li> </ul>	Mass and balance documents of various Aircraft types.
031 03 03 00	<b><u>Securing of Load</u></b>	
031 03 03 01	<b>Importance of adequate tie-down</b> <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 aeroplanes use pallets or containers to secure the load</li> </ul>	
031 03 03 02	<b>Effect of loadshift</b> <ul style="list-style-type: none"> <li>– Explain and calculate the effect of Loadshift</li> <li>– See 031 03 02 02</li> </ul>	

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031 03 04 00	<u>Area Load, Running Load, Supporting</u> – See 031 01 02 02	