**Assignment**

Using the data of the given aircraft to

1. Calculate the short-period, roll-subsidence and Dutch-roll mode parameters, including ;
2. Evaluate the flying quality for Category A flight phases;
3. Design proper flight control system to make the aircraft has Level I flying quality

For the given flight condition: H=5000m, M=0.8; H=8000m, M=0.8; H=14000m, M=1.4.

**Steps:**

* Define the flight condition
* Define the geometry and mass data
* Calculate the airspeed and density based on flight condition, using the atmosphere model
* Load aerodynamic data
* Calculate the aerodynamic derivatives based on the flight condition using interpolation
* Calculate the matrix
* Calculate the mode parameters, i.e., , and

**Geometry Data**

|  |  |  |
| --- | --- | --- |
| Parameter |  | Unit |
|  | 23 |  |
|  | 7.15 |  |
|  | 4.002 |  |
|  | 6000 |  |
|  | 4312 |  |
|  | 45374 |  |
|  | 48216 |  |
|  | 0 |  |

**Atmosphere Model**

If H<11000m



If H>=11000m and H<20000m



Density and Airspeed



**Equation of Motion**

**Longitudinal**



,





**Lateral**





 







**Longitudinal Aerodynamic Data**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H | Ma |  |  |  |  |  |  |  |  |
| 0 | 0.6 | 0.049134 | -0.061853 | -0.007654 | 0.007516 | -1.352448 | -0.68187 | -0.003039 | -0.004 |
| 0.65 | 0.049152 | -0.061533 | -0.007429 | 0.007233 | -1.331722 | -0.69576 | -0.003024 | -0.003938 |
| 0.7 | 0.049275 | -0.061298 | -0.007227 | 0.00696 | -1.316724 | -0.711698 | -0.00302 | -0.004 |
| 0.75 | 0.049285 | -0.060591 | -0.007102 | 0.006751 | -1.31355 | -0.719744 | -0.002986 | -0.004125 |
| 0.8 | 0.049808 | -0.061364 | -0.006925 | 0.006485 | -1.310812 | -0.747389 | -0.003056 | -0.0045 |
| 0.85 | 0.050458 | -0.056698 | -0.006704 | 0.006225 | -1.310943 | -0.76016 | -0.002861 | -0.00588 |
| 0.89 | 0.051936 | -0.064577 | -0.006576 | 0.005983 | -1.311692 | -0.82838 | -0.003354 | -0.00588 |
| 3 | 0.6 | 0.049813 | -0.065142 | -0.008173 | 0.008018 | -1.428057 | -0.701682 | -0.003245 | -0.004 |
| 0.7 | 0.050247 | -0.064988 | -0.007861 | 0.007561 | -1.416511 | -0.739499 | -0.003266 | -0.004 |
| 0.8 | 0.051114 | -0.064963 | -0.007613 | 0.007117 | -1.426153 | -0.785726 | -0.003321 | -0.0045 |
| 0.85 | 0.05192 | -0.059929 | -0.007438 | 0.006894 | -1.441501 | -0.804845 | -0.003112 | -0.005335 |
| 0.9 | 0.054187 | -0.072319 | -0.007399 | 0.006672 | -1.470148 | -0.911483 | -0.003919 | -0.0065 |
| 0.959 | 0.057683 | -0.100099 | -0.007359 | 0.006345 | -1.488155 | -1.094159 | -0.005774 | -0.0065 |
| 1.018 | 0.054401 | -0.139592 | -0.006882 | 0.005774 | -1.416703 | -1.079232 | -0.007594 | -0.007058 |
| 5 | 0.6 | 0.050181 | -0.067 | -0.008468 | 0.008304 | -1.470788 | -0.712302 | -0.003362 | -0.004 |
| 0.7 | 0.050788 | -0.067203 | -0.008243 | 0.007923 | -1.475907 | -0.75469 | -0.003413 | -0.004 |
| 0.8 | 0.051882 | -0.067421 | -0.008086 | 0.007553 | -1.50342 | -0.807499 | -0.003498 | -0.0045 |
| 0.9 | 0.055177 | -0.074666 | -0.007889 | 0.007105 | -1.56125 | -0.944372 | -0.00412 | -0.006 |
| 1 | 0.057773 | -0.139723 | -0.007766 | 0.006529 | -1.604251 | -1.221508 | -0.008072 | -0.007 |
| 1.1 | 0.054718 | -0.162558 | -0.006904 | 0.005795 | -1.543589 | -0.894465 | -0.008895 | -0.007 |
| 1.265 | 0.050743 | -0.175728 | -0.00541 | 0.004635 | -1.282072 | -0.622324 | -0.008917 | -0.003936 |
| 8 | 0.7 | 0.05144 | -0.06997 | -0.008726 | 0.008382 | -1.550567 | -0.772805 | -0.003599 | -0.004 |
| 0.85 | 0.053881 | -0.065182 | -0.008649 | 0.007999 | -1.649769 | -0.862703 | -0.003512 | -0.005333 |
| 1 | 0.059819 | -0.146665 | -0.008675 | 0.007281 | -1.79449 | -1.303964 | -0.008773 | -0.007 |
| 1.1 | 0.056965 | -0.173093 | -0.007899 | 0.006613 | -1.752683 | -0.791361 | -0.00986 | -0.007 |
| 1.2 | 0.054372 | -0.185887 | -0.007022 | 0.005877 | -1.601885 | -0.770582 | -0.010107 | -0.006 |
| 1.3 | 0.052629 | -0.191936 | -0.006145 | 0.005296 | -1.439433 | -0.635595 | -0.010101 | -0.003 |
| 1.505 | 0.048309 | -0.190349 | -0.00471 | 0.004405 | -1.166491 | -0.443293 | -0.009196 | 0.000004 |
| 10 | 0.7 | 0.051777 | -0.071439 | -0.008985 | 0.008627 | -1.590357 | -0.782104 | -0.003699 | -0.004 |
| 0.9 | 0.057216 | -0.080334 | -0.009137 | 0.008213 | -1.785426 | -1.009267 | -0.004596 | -0.006 |
| 1 | 0.061046 | -0.151107 | -0.009302 | 0.007799 | -1.923216 | -1.353289 | -0.009224 | -0.007 |
| 1.2 | 0.055978 | -0.195356 | -0.007836 | 0.006542 | -1.762919 | -0.81117 | -0.010936 | -0.006 |
| 1.3 | 0.054075 | -0.200377 | -0.006739 | 0.005794 | -1.562019 | -0.666854 | -0.010835 | -0.003 |
| 1.5 | 0.04997 | -0.202259 | -0.005353 | 0.004982 | -1.302829 | -0.461777 | -0.010107 | 0 |
| 1.712 | 0.044438 | -0.193633 | -0.004176 | 0.004068 | -1.032418 | -0.312294 | -0.008605 | 0 |

**Lateral-Directional Aerodynamic Data**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H | Ma |  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0.6 | -0.01465 | -0.001162 | 0.002563 | 0.001123 | -0.000175 | -0.000846 | -0.001158 | -0.177226 | -0.500806 | -0.054195 | -0.070223 |
| 0.65 | -0.01432 | -0.001078 | 0.002388 | 0.001008 | -0.000157 | -0.000767 | -0.001108 | -0.175531 | -0.49232 | -0.054138 | -0.06733 |
| 0.7 | -0.014 | -0.001003 | 0.002233 | 0.000896 | -0.000139 | -0.00069 | -0.001051 | -0.174449 | -0.48634 | -0.054068 | -0.065004 |
| 0.75 | -0.0137 | -0.000933 | 0.002126 | 0.00083 | -0.000128 | -0.000641 | -0.000989 | -0.174482 | -0.488417 | -0.054475 | -0.063813 |
| 0.8 | -0.01343 | -0.000871 | 0.001998 | 0.000717 | -0.000111 | -0.000571 | -0.000916 | -0.174009 | -0.485736 | -0.054429 | -0.062247 |
| 0.85 | -0.01325 | -0.000818 | 0.001878 | 0.000597 | -0.000093 | -0.000505 | -0.00084 | -0.17093 | -0.477364 | -0.054632 | -0.060999 |
| 0.89 | -0.01311 | -0.00078 | 0.001783 | 0.000501 | -0.00008 | -0.000451 | -0.000765 | -0.171269 | -0.475552 | -0.054279 | -0.059777 |
| 3 | 0.6 | -0.01511 | -0.001361 | 0.002805 | 0.001344 | -0.000213 | -0.000998 | -0.001228 | -0.180342 | -0.524674 | -0.057369 | -0.081807 |
| 0.7 | -0.01448 | -0.001163 | 0.002505 | 0.00114 | -0.00018 | -0.000859 | -0.001143 | -0.178675 | -0.514419 | -0.058153 | -0.075348 |
| 0.8 | -0.0139 | -0.001 | 0.002272 | 0.000924 | -0.000144 | -0.000715 | -0.00103 | -0.179509 | -0.512287 | -0.058713 | -0.07111 |
| 0.85 | -0.01374 | -0.000941 | 0.00217 | 0.000798 | -0.000126 | -0.00065 | -0.000966 | -0.177105 | -0.504661 | -0.0593 | -0.069518 |
| 0.9 | -0.01363 | -0.000893 | 0.002103 | 0.000709 | -0.000115 | -0.000614 | -0.000885 | -0.179067 | -0.508171 | -0.059729 | -0.068502 |
| 0.95 | -0.0135 | -0.000847 | 0.002005 | 0.00058 | -0.000098 | -0.000546 | -0.000785 | -0.184234 | -0.514386 | -0.0589 | -0.066468 |
| 1.018 | -0.01341 | -0.000778 | 0.001793 | 0.000393 | -0.000067 | -0.000391 | -0.000391 | -0.178272 | -0.506353 | -0.056859 | -0.064916 |
| 5 | 0.6 | -0.01542 | -0.001539 | 0.002954 | 0.001475 | -0.000237 | -0.001088 | -0.001265 | -0.181979 | -0.539751 | -0.059154 | -0.091615 |
| 0.7 | -0.01481 | -0.001303 | 0.002681 | 0.0013 | -0.000208 | -0.000968 | -0.001194 | -0.180983 | -0.53354 | -0.060677 | -0.083889 |
| 0.8 | -0.01425 | -0.001115 | 0.002479 | 0.001102 | -0.000174 | -0.000838 | -0.001096 | -0.182699 | -0.534032 | -0.061831 | -0.078902 |
| 0.9 | -0.01397 | -0.000988 | 0.002298 | 0.000833 | -0.000136 | -0.00071 | -0.000965 | -0.18313 | -0.526818 | -0.062788 | -0.074911 |
| 1 | -0.01393 | -0.000889 | 0.002132 | 0.000605 | -0.000104 | -0.000566 | -0.0007 | -0.192309 | -0.537379 | -0.062224 | -0.073001 |
| 1.1 | -0.01376 | -0.000781 | 0.001931 | 0.000327 | -0.000061 | -0.000324 | -0.000399 | -0.177831 | -0.527219 | -0.05793 | -0.067053 |
| 1.265 | -0.01345 | -0.000559 | 0.00192 | 0.000106 | -0.000023 | -0.000127 | -0.000299 | -0.169904 | -0.55426 | -0.056923 | -0.062751 |
| 8 | 0.7 | -0.01532 | -0.001593 | 0.002923 | 0.00151 | -0.000249 | -0.001113 | -0.001254 | -0.183656 | -0.56193 | -0.063935 | -0.100498 |
| 0.85 | -0.0147 | -0.001265 | 0.002716 | 0.001237 | -0.000201 | -0.000966 | -0.001131 | -0.185183 | -0.561999 | -0.067434 | -0.09078 |
| 1 | -0.01454 | -0.001056 | 0.002494 | 0.000823 | -0.000144 | -0.000743 | -0.000838 | -0.20089 | -0.574043 | -0.067852 | -0.085544 |
| 1.1 | -0.01437 | -0.00093 | 0.002304 | 0.000482 | -0.000091 | -0.000449 | -0.000545 | -0.187588 | -0.563935 | -0.063989 | -0.078516 |
| 1.2 | -0.01415 | -0.000765 | 0.002379 | 0.000258 | -0.000052 | -0.000255 | -0.000467 | -0.183321 | -0.576533 | -0.062807 | -0.074111 |
| 1.3 | -0.01385 | -0.000631 | 0.002105 | 0.000202 | -0.000042 | -0.000199 | -0.000412 | -0.17704 | -0.618098 | -0.066271 | -0.074584 |
| 1.505 | -0.01313 | -0.000465 | 0.00173 | 0.000109 | -0.000022 | -0.000108 | -0.000298 | -0.170271 | -0.579571 | -0.062926 | -0.066663 |