> 1. You can solve this homework individually, or in groups of two. 2. Make reasonable assumptions, STATE them, and include any references you might have used. 3. Extra points are reserved for neat and systematic presentation of results. 4. Plagiarism ⇒ Course fail (this has happened).

In this exercise, you will use integral equation methods to compute the radar cross-section of an aircraft of your choice. The objective is to give you a feel for the sort of design choices that need to be made to solve real world problems. Proceed in these steps:

1. Obtain a 2D view of the aircraft. There are many such images available on the internet. One site with a lot of examples is: `https://www.fiddlersgreen.net/shop/category/name/Aircraft.html`. Look for a side view image such as the bottom most part of Figure 1.

2. Assume that the entire body of the aircraft can be modelled as a PEC or a homogeneous dielectric, so that the interior of the aircraft need not be modelled. Obtain an outline of the side view using Matlab or any other image processing tool. This code must take as input a side view, a discretization parameter, and outputs the coordinates of the discretized contour in a usable format. A sample code for doing this can be downloaded from here: `http://www.ee.iitm.ac.in/uday/2018a-EE6506/code/extract_shape.m`. For the PEC or dielectric scattering code, you may use the codes here as a starting point: `http://www.ee.iitm.ac.in/uday/2018a-EE6506/code/`

3. Now, discretize the outline into segments of length $\approx \lambda/15$ and compute the 2D RCS of the aircraft for E_z polarization. Be sure to write down the problem formulation properly starting from the operator viewpoint, then the matrix elements, and finally the expression for the radar cross-section.
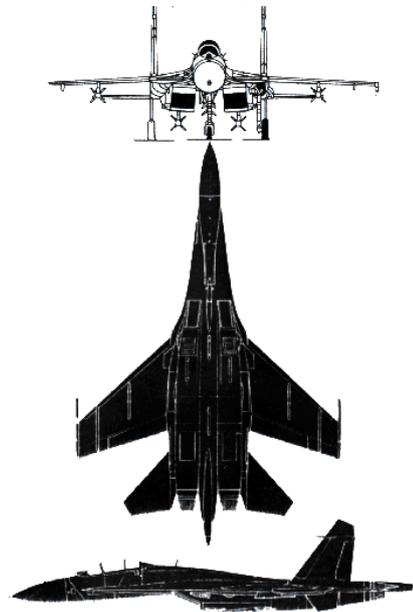

Figure 1: Views of Sukhoi-27. Credit: `http://www.fiddlersgreen.net/models/aircraft/Sukhoi-Su27.html`

4. Assume the aircraft is illuminated by a S-band radar wave (3 GHz) at $45°$ from the x-axis, and that the aircraft is level with the ground and heading in the direction of the radar. Plot the RCS at all angles, and mention what the radar would measure assuming the aircraft is:
(a) all PEC (metal), OR
(b) all carbon fibre. Look up and find the permittivity at this radar wavelength, reporting the source.

5. Make suitable assumptions about the scale of your model (i.e. ratio of simulated aircraft size to actual aircraft size). First attempt a 1:1 model, and if it doesn't work (due to the size of the matrix becoming too large), attempt the closest scale that is feasible. Tip: keep your image fixed, and change the wavelength to get the correct size/wavelength ratio. For e.g. the physical dimension of an aircraft might be around 20m, and the radar wavelength is 10cm at 3GHz. If your image is now 20cm, then chose a wavelength of 1mm to simulate a 1:1 model. If you shrink your image to 10cm, OR increase your wavelength to 2mm, you have simulated a 1:2 model.

6. This part will be done by all students of the course with instructor's guidance, and does not have the above due date. Understand, explain, and implement an accelerator for the above code using the multi-level fast multipole method (ML-FMM).