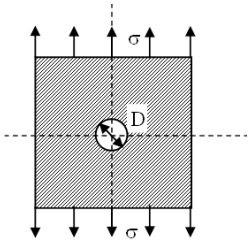
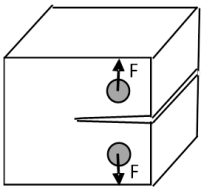
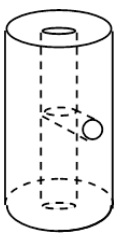
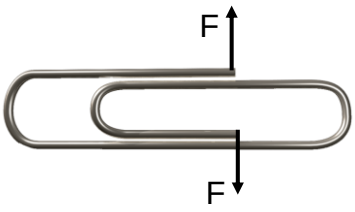
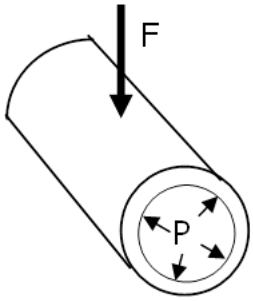
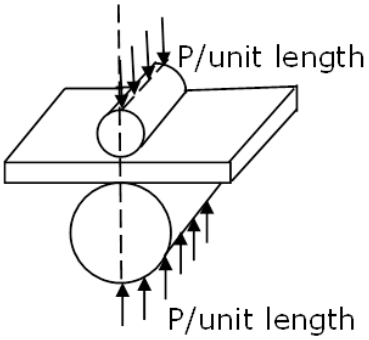
University of Nottingham
Department of Mechanical, Materials and Manufacturing Engineering
MM3CMQ (Computer Modelling Techniques)

SOLUTIONS
Exercise Sheet (FE)-2
(Choosing elements)

Which elements would you recommend for the examples shown below? Note that more than one type of element may be suitable.

Example	Element Type	Reason
1. A thin square plate with a central circular hole subjected to a uniaxial stress. 	2D plane stress continuum element	Since the plate is thin in the z-direction, a 2D plane stress continuum element would be suitable since stress in the z-direction is assumed to be zero. Quadratic elements (rather than linear elements) would be recommended since the geometry is curved around the hole.
2. A standard fracture test specimen (called compact tension specimen) used to determine the fracture toughness of materials. Loading is applied to open the crack using pins inserted in circular holes. 	2D plane stress, 2D plane strain or 3D continuum elements	Although the geometry appears to be three-dimensional, the stress distribution in the x-y plane will not be significantly affected by the thickness of the plate (in the z-direction). Therefore, any continuum element can be used (2D plane stress, 2D plane strain or 3D). However, it is not recommended to use 3D elements for this problem, since it will take much longer to design the mesh and the computational time will be substantially increased.
3. A thick-walled pressurised pipe containing a pressurised fluid. 	3D continuum element	The geometry is fully three-dimensional. It cannot be approximated to a 2D plane stress or a 2D plane strain problem (or axisymmetric). Therefore, 3D continuum elements would be suitable. Since the geometry is curved, quadratic 3D elements would be better than linear 3D elements.

4. A paper clip loaded by two forces as shown.  	Beam element	The paper clip will be subjected to bending under the action of the applied forces. The paper clip is effectively a curved beam where the thickness (the cross-section) is much smaller than the length of the beam. For such a problem dominated by bending, beam elements are recommended.
5. A thin-walled gas pipe subjected to a concentrated point force.  	3D continuum element	Here the geometry of the pipe is axisymmetric, but the applied load is not axisymmetric. Therefore, 3D continuum elements would be appropriate. Note that it is not possible to use a 2D plane stress or a 2D plane strain model to represent this problem. Since the pipe wall is relatively thin, 3D thin shell elements can also be used instead of 3D continuum elements.
6. Two steel cylindrical rollers pressed on a flat block.  	2D plane stress, 2D plane strain or 3D continuum element	This is a contact problem. Although the geometry appears to be three-dimensional, the load is applied across the whole of the z-direction, which means that any x-y plane can be used to represent this problem. Therefore, any continuum element can be used (2D plane stress, 2D plane strain or 3D). A 2D plane strain model would be recommended since it assumes that the length in the z-direction is very large compared to the other dimensions. 3D continuum elements can be used, but would consume much more computational time and take longer to design the mesh.