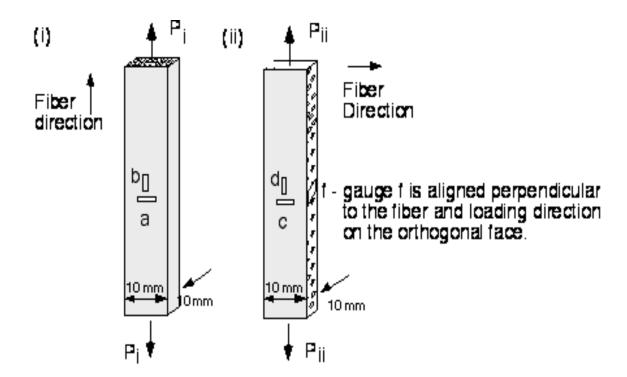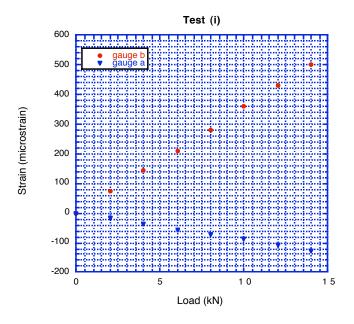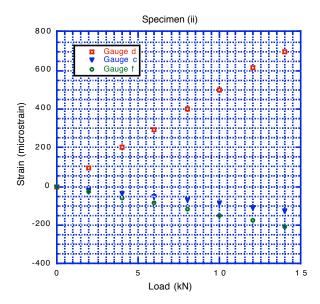**Problem M19**

Silicon carbide fiber reinforced titanium matrix composites are being considered for use in the compressor stages of next generation gas turbine engines.  It is required to obtain the elastic properties of a batch of material under development.  To do this, two test specimens are machined from the batch, each 200 mm long and 10 mm by 10 mm in width and thickness.  Two strain gauges are attached to specimens (i) in which the load is applied parallel to the fiber direction and three are applied to specimen (ii) which is loaded perpendicular to the fiber direction as shown below.   A uniaxial load, P is applied through a mechanical testing machine, which is varied from 0 to 14 kN.



a)   What is the fewest number of independent engineering elastic constants that you would expect to be required to describe the elastic constitutive behavior of this material?.  State any assumptions that you are making in giving this number.

**Test (i)** — Strain (microstrain) vs. Load (kN); gauge b, gauge a

**Specimen (ii)** — Strain (microstrain) vs. Load (kN); Gauge d, Gauge c, Gauge f

b) The graphs above show the strain readings plotted vs. applied load for the two tests. Using the information contained in the graphs calculate **all** the engineering elastic constants that you can obtain. If there are any elastic constants that you cannot obtain/estimate from this data suggest additional tests that you might perform in order to obtain them. In describing the elastic constants use x, y and z to indicate the orthogonal material directions, with x aligned parallel to the fibers.

c) Estimate the fiber volume fraction for this composite, given that the Young's modulus of SiC is 450 GPa, and the Poisson's ratio is 0.16 and the corresponding values for the titanium alloy used for a matrix are 110 GPa and 0.34 respectively. Is this consistent with the data provided?