1. Use Lagrange's equation to find the equations of motion of a particle in terms of the polar coordinate variables r and θ.

2. Find the following equation of the quadric surface relative to principal axes

$$x^2+6xy-2y^2-2yz+z^2= 24$$

3. Given $f(x)= \begin{cases} 1, & 0 < x < L \\ 0, & L < x < 2L \end{cases}$

   Expand $f(x)$ in an exponential Fourier series of period $2L$.

4. Solve second-order differential equation;　$y''+y'-2y= 4 \sin 2x$

5. The Pauli spin matrices in quantum mechanics are

$$A=\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} ; \qquad B=\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} ; \qquad C=\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

   Show that $A^2= B^2 = C^2 =1$. (Note carefully that this 1 means the 2x2 unit matrix and not the number 1). Also show that any pair of these matrices is an anticommute.