1. A cutting tool under microprocessor control has several forces acting on it. One force is $\mathbf{F} = -\alpha x y^2 \mathbf{j}$, a force in the negative y-direction whose magnitude depends on the position of the tool. The constant is $\alpha = 1.50\ \mathrm{N/m^2}$. Consider the displacement of the tool from the origin to the point $x = 2.00$ m, $y = 2.00$ m.
   a) Calculate the work done on the tool by **F** if this displacement is along the straight line $y = x$ that connects these two points.
   b) Calculate the work done on the tool by **F** if the tool is first moved out along the x-axis to the point $x = 2.00$ m, $y = 0$ and then moved parallel to the y-axis to $x = 2.00$ m, $y = 2.00$ m.
   c) Is **F** conservative or non-conservative? (15%)

2. An approximation for the potential energy of a KCl molecule is
   $U = A\,[\,(R_0^7 / 8r^8) - 1/r\,]$,
   where $R_0 = 2.67\times10^{-10}$ m and $A = 2.31\times10^{-28}$ J·m. Using this approximation :
   a) Find the radical component of the force on each atom
   b) Show that R_0 is the equilibrium separation.
   c) Find the minimum potential energy.
   d) Use $r = R_0 + x$ and $x \ll R_0$, to show that $F = -(7A / R_0^3)\,x$ and that the molecule's force constant is $k = 7A / R_0^3$. (16%)

3. Transverse waves on a string have wave speed 12.0 m/s, amplitude 0.0500 m, and wavelength 0.400 m. The waves travel in the $+x$-direction, and at $t = 0$ the $x = 0$ end of the string has zero displacement and is moving upward.
   a) Find the frequency, period, and wave number of these waves.
   b) Write a wave function describing the wave.
   c) Find the transverse displacement of a point at $x = 0.250$ m at time $t = 0.150$ s.
   d) How much time must elapse from the instant in part c) until the point at $x = 0.250$ m has zero displacement? (16%)

(背面仍有題目,請繼續作答)

4.Suppose the parallel plates of a capacitor each have an area of 2000 cm^2 and are 1.0 cm apart. The capacitor is connected to a power supply and charged to a potential difference V_0 = 3000 V. It is then disconnected from the power supply, and a sheet of insulating plastic material is inserted between the plates, completely filling the space between them. We find that the potential difference decreases to 1000 V while the charge on each capacitor plate remains constant. Compute

a) the original capacitance C_0;

b) the magnitude of charge Q on each plate;

c) the capacitance C after the dielectric is inserted;

d) the dielectric constant K of the dielectric;

e) the permittivity ϵ of the dielectric;

f) the magnitude of the induced charge Q_i on each face of the dielectric;

g) the original electric field E_0 between the plates; and

h) the electric field E after the dielectric is inserted. (16%)

5.Suppose an inductor with inductance *L* and a resistor of resistance *R* are connected in series across the terminals of a charged capacitor *C* with initial charge Q,forming a series *RLC* circuit. Discuss the series *RLC* circuit behavior for different magnitude of *R*. (20%)

6.Describe the (classical) theory of metallic conduction and calculate its resistivity. (17%)