編號： 207　系所：奈米科技暨微系統工程研究所　　科目：電磁學

本試題是否可以使用計算機：☑可使用 ，☐不可使用　（請命題老師勾選）

1. (1) Explain the meaning of gradient Φ (i.e., $\nabla\Phi$), where Φ is a scalar field. **(10%)**
   (2) Given $\Phi = xyz^2+x^2y^3$, find the directional derivative $d\Phi/dl$ in the direction 1 $\mathbf{a}_x$ +2 $\mathbf{a}_y$ +2 $\mathbf{a}_z$ at point (1,1,2). **(10%)**

2. For a coaxial cable, inner conductor radius a, outer conductor radius b (b>a), cable length L, the homogeneous dielectric with permittivity ε and conductivity σ is filled between two conductors. Assume that inner and outer conductors carry +Q and –Q, respectively. Find (1) the capacitance of the coaxial cable and (2) the leakage resistance between two conductors. **(20%)**

3. A circular loop located at $x^2+y^2=16$, $z=0$ carries 5 Ampere current along $\mathbf{a}_\phi$. Determine magnetic field intensity **H** at points (0, 0, 3) and (0, 0, -3). Using cylindrical coordinates (ρ, ϕ, z) to solve it. **(20%)**

4. Find the Laplacian of the scalar fields shown below. **(20%)**
   (1) $V=e^{-x}\sin(y)\sinh(z)$.
   (2) $W=5r^2\sin(\theta)\cos^2(\phi)$.
   By definition, spherical coordinates (r, θ, ϕ) and cylindrical coordinates (ρ, ϕ, z).

5. A 2-meter-long transmission line operates at $\omega=10^6$ rad/s with $\alpha=1$ rad/m and $\beta=2$ rad/s, $Z_o=20+j10\ \Omega$. The line is connected to an input source of $2\angle 30^\circ$ V with source resistance 40Ω and terminated by a load of $10+j20\Omega$. Find (1) the input impedance, (2) the sending-end current, (3) the current at one fourth of the line. **(20%)**