國立中山大學 111 學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：工程數學【光電系碩士班】

1. (a) Why are Fourier series important? (5%)
   (b) Are there any real-life applications of Fourier series? (5%)
   (c) How does a Fourier transform work? (5%)
   Please describe above questions with examples in details.

2. (20%) Compute and graph $f * g$; where $f(t) = h(t) - h(t-1)$ and $g(t) = h(t-1) - 2h(t-2)$

3. (15%) Evaluate the integral $\int_{-\infty}^{\infty} \frac{x^2}{(x^2+1)(x^2+4)} dx$

4. (15%) Find the solution of the initial value problem. $y' + xy = xy^{-1}$, $y(0) = 4$

5. (20%) $x^3 y''' - 3x^2 y'' + 6xy' - 6y = x^4 \ln x$ ，solve the nonhomogeneous Euler-Cauchy equation, where x is greater than 0.

6. (15%) Solve $\frac{\partial u}{\partial x} = 6\frac{\partial u}{\partial t} + u$ using the method of separation of variables if $u(x,0) = 10e^{-x}$

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科目名稱：電磁學【光電系碩士班】

1. Explain the Helmholtz's theorem. (5%)

2. An electric dipole consists of +q and –q positioned at z = d/2 and z = -d/2 on the z-axis, respectively. Consider the field point P(R,θ,ϕ) in the far-field region with R>>d. Please derive the free-space electrostatic potential V(R,θ,ϕ) and electrostatic field $\vec{E}$(R,θ,ϕ) at this point. (10%)

3. In the formulation of electromagnetism, Maxwell described light as a propagating wave of electric and magnetic fields. Please describe how Maxwell predicted the existence of electromagnetic radiation – coupled electric and magnetic fields traveling as waves at a speed equal to the known speed of light. (10%)

4. What are the boundary conditions for electrostatic fields at an interface between a conductor and a dielectric with permittivity ε, assuming that there is a surface charge density σ on this interface? (5%)

5. Assuming that charges of magnitude Q are installed in the parallel-plate capacitors as shown in the following figures, please find the electric field $\vec{E}$, and the capacitance. (20%)
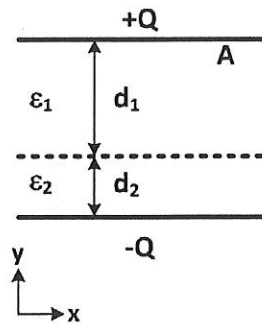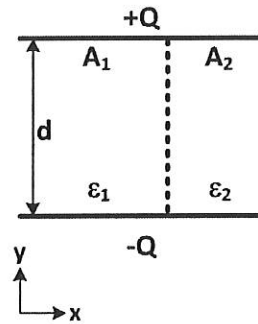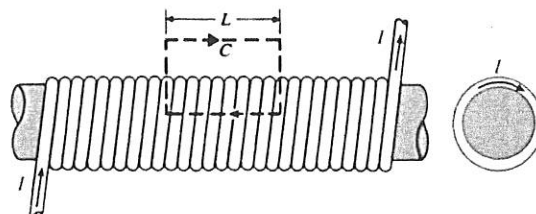

6. Determine the magnetic flux density inside an infinitely long solenoid with air core having n closely wound turns per unit length and carrying a current I. (10%)

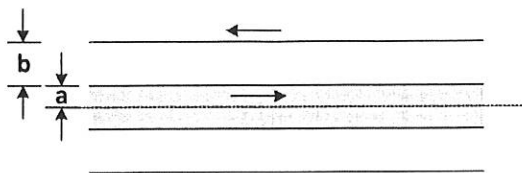7. Please write down the Maxwell's equations and their respective physical meanings. (10%)

8. An air coaxial transmission line has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. Determine the inductance per unit length of the line. (10%)

9. Determine the mutual inductance between a very long, straight wire and a conducting equilateral rectangular loop. (10%)
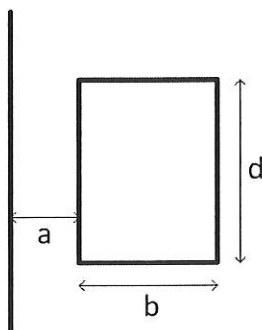
10. A point charge +q is at a distance d from the center of a grounded conducting sphere of a radius a (a<d) as indicated in the following figure. Please determine (a) the potential distribution and electric field intensity inside and outside the sphere (5%) and (b) the charge distribution induced on the surface of the sphere (5%).