Ready for Fields&Waves?

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The following questions cover a range of topics you should master (i.e. $>75\%$ correct answers) before starting the course Fields&Waves in the Electrical Systems Engineering programm at Paderborn University:

1. Evaluate
   (a) $\sin\frac{\pi}{2} =$
   (b) $\cos\frac{\pi}{2} =$
   (c) $\sin^2 x + \cos^2 x =$
   (d) $\exp(0) =$
   (e) $\exp(-\frac{\pi}{2}j) =$
2. Express e^{jx} in terms of sin and cos (Euler's identity): $e^{jx} =$
3. Give the general real-valued solution of the ODEs
   (a) $\frac{d^2}{dt^2}y(t) = -\omega^2 y(t)$ (with $\omega \neq 0$): $y(t) =$
   (b) $\frac{d}{dt}y(t) = -\gamma y(t)$ (with $\gamma \neq 0$): $y(t) =$
4. Give the solution of the Fourier integral $g(\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-j\omega t} dt$ for
   (a) $g(t) = \frac{d}{dt}f(t)$ (assume $f(\omega)$ is known): $\Rightarrow g(\omega) =$
   (b) $g(t) = f(t)\, e^{j\omega_0 t}$ (assume $f(\omega)$ is known)$\Rightarrow g(\omega) =$
   (c) $g(t) = \sin(\omega_0 t) \;\Rightarrow g(\omega) =$
5. Vector products, Give
   (a) the projection of a vector $\vec{a}$ on a normalized vector $\vec{n}$:
   (b) the inner product $\vec{a} \cdot \vec{b}$ in cartesian coordinates:
   (c) the length of a vector $\vec{a}$ using the innter product:
   (d) the vector product $\vec{a} \times \vec{b}$ in cartesian coordinates:
6. Evaluate the following expressions (or mark if invalid):
   (a) $\operatorname{grad} 5 =$
   (b) $\operatorname{curl} 4 =$
   (c) $\operatorname{grad}(x^2 + y^3) =$
   (d) $\operatorname{curl}\operatorname{grad}\vec{v}(\vec{r}) =$
   (e) $\operatorname{div}\begin{pmatrix} x \\ y \\ z \end{pmatrix} =$
   (f) $\operatorname{curl}\begin{pmatrix} 0 \\ 0 \\ y \end{pmatrix} =$

7. State Stokes' and Gauss' theorems:
   (a) $\int_V \operatorname{div} \vec{v}(\vec{r})\, dV =$
   (b) $\int_A \operatorname{curl} \vec{v}(\vec{r}) \cdot d\vec{a} =$
8. Give the electrostatic potential of a point charge q located at the the position $\vec{s}$: $\varphi(\vec{r}) =$
9. Write down the four Maxwell equations (for material/medium, in differential form, SI units):
   (a)
   (b)
   (c)
   (d)
10. Which electric and magnetic field components are continuous at an interface?
11. For a perfect electric conductor, the electric field strength
    (a) inside is:
    (b) at the surface is:
12. In a medium give (in terms of the real-valued e.m. fields) the definitions of
    (a) the Poynting vector: $\vec{S} =$
    (b) the electromagnetic energy (in a volume V): $W =$
13. Give the units (in SI) of
    (a) the electric field strength: $[\vec{E}] =$
    (b) the magnetic flux denisity: $[\vec{B}] =$
    (c) the current density: $[\vec{J}] =$
    (d) the charge density: $[\rho] =$