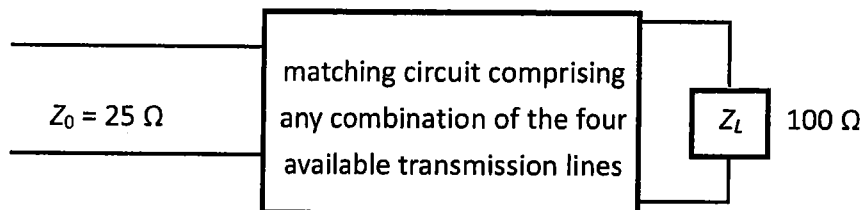


※請在答案卷內作答

Note: Detailed Derivations are required to obtain a full score for each problem.

1. (10 pts) What is the position vector \mathbf{R} to an arbitrary point (x, y, z) in Cartesian coordinates? And what is the divergence of \mathbf{R} ? Here the base vectors are \mathbf{a}_x , \mathbf{a}_y , and \mathbf{a}_z .
2. (5 pts) When the dielectric medium is lossy (having a small but non-zero conductivity σ), the capacitance between two conductors separated by this dielectric medium can be defined as C while the resistance between these two conductors is R . Please prove that $RC = \epsilon/\sigma$. Here ϵ is the permittivity of the medium.
3. Consider oblique incidence from medium 1 to medium 2 problems:
 - (a) (10 pts) Derive the reflection coefficient and transmission coefficient with perpendicular polarization incidence at a plane dielectric boundary.
 - (b) (10 pts) Derive the reflection coefficient and transmission coefficient with parallel polarization incidence at a plane dielectric boundary.
 - (c) (10 pts) Define the Brewster angle and the critical angle, respectively.
4. (10 pts) A load $Z_L = 100 \Omega$ is to be matched to a transmission line with characteristic impedance $Z_0 = 25 \Omega$. Four quarter-wave transmission lines, each of length $= \lambda/4$, with various characteristic impedances: $Z_1 = 45 \Omega$, $Z_2 = 60 \Omega$, $Z_3 = 75 \Omega$, and $Z_4 = 90 \Omega$ are available. Find a way to achieve this matching by using any combination of these four available transmission lines and draw the matching circuit. Explicit working must be shown to motivate or explain the solution. Hint: Not necessary to use all four transmission lines.



5. The standing-wave ratio on a lossless 50Ω transmission line terminated in an unknown load impedance is found to be 3.0. The distance between successive voltage minima is 20 cm, and the first minimum is located at 5 cm from the load. Determine
 - (a) (4 pts) the reflection coefficient,
 - (b) (3 pts) the load impedance, and
 - (c) (3 pts) the shortest possible equivalent length and the associated terminating resistance of such a transmission line inserted in place of the original load such that the input impedance seen into this replacement line towards its terminal resistance is equal to the original load impedance found in (b).

參考用

注意：背面有試題

※請在答案卷內作答

6. A dielectric-filled metallic waveguide of unknown permittivity has dimension $a=2$ cm and $b=4$ cm along x and y directions respectively. Now the magnetic field of a guided mode propagating along this metallic waveguide is known as

$$H = \hat{y}30 \cos(100\pi x) \sin(200\pi y) \sin(2\pi \times 10^{10} t - 557\pi z) \text{ (A/m)}$$

Determine

- (a) (5 pts) the mode number of this guided mode
 - (b) (5 pts) ϵ_r (dielectric constant) of the filled dielectric material
 - (c) (5 pts) the cutoff frequency of this guided mode
7. Consider a InGaAsP-InP laser diode which has an optical cavity of length 150 microns. The peak radiation is at 1550 nm and the refractive index of InGaAsP is 4. The optical gain bandwidth (as measured between half intensity points) will normally depend on the pumping current (diode current) but for this problem assume that it is 5 nm.
- (a) (5 pts) What is the mode integer m of the peak radiation?
 - (b) (5 pts) What is the separation between the modes of the cavity? Please express your answer as $\Delta\lambda$.
 - (c) (5 pts) How many modes are within the gain band of the laser?
 - (d) (5 pts) What is the reflection coefficient and reflectance at the ends of the optical cavity (faces of the InGaAsP crystal)?

※請在答案卷內作答

一、(20%) 申論題:請提綱契領闡述以下子題。

- (一)、(5%) Describe the differences in the rotors of salient-pole and non-salient pole synchronous machines.
- (二)、(5%) Describe the differences between induction motor and synchronous motor in line drawn power factors.
- (三)、(5%) What is the v-curve of a synchronous motor?
- (四)、(5%) For the given Fig. 1: 1. what is infinite bus? 2. an incoming generator is to be paralleled to the infinite bus, give the conditions for successful operation.

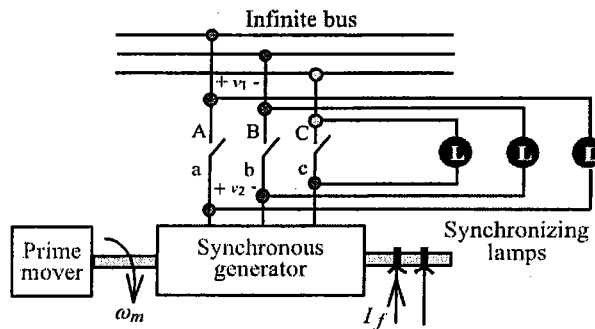


Fig. 1

二、(10%) 計算題:請詳列計算過程，無計算過程者不予計分。

- (一)、(5%) $i(t) = 10 + \sqrt{2} 20 \sin(377t)$ (A), find its rms value.
- (二)、(5%) A delta-delta three-phase transformer bank has the ratings of 100kVA/2200V. If one transformer cell is faulted and removed, find the new ratings of the resulted V-V three-phase transformer bank.

三、(15%) 計算題:請詳列計算過程，無計算過程者不予計分。

As shown in Fig. 2, an 11kV synchronous generator is connected to a 11kV/66kV transformer which feeds a 66kV/11kV/3.3kV three-winding transformer through a short feeder with negligible impedance. Calculate the fault current when a single-phase-to-earth fault occurs on a terminal of the 11kV winding of the three-winding transformer. The relevant data for the system are as follows:

Generator $X_1 = j0.15 \text{ p.u.}$, $X_2 = j0.1 \text{ p.u.}$, $X_0 = j0.03 \text{ p.u.}$, all on a 10MVA base; star point of the winding earthed through a 3ohm resistor;

11kV/66kV transformer $X_1 = X_2 = X_0 = j0.1 \text{ p.u.}$ on a 10MVA base; 11kV winding delta connected and the 66kV winding star connected with the star point solidly earthed.

Three-winding Transformer A 66kV winding, star connected, star point solidly earthed; 11kV winding, star connected, star-point earthed through a 3ohm resistor; 3.3kV winding, delta connected; the three windings of an equivalent star connection to represent the transformer have sequence impedances, 66kV winding $X_1 = X_2 = X_0 = j0.04 \text{ p.u.}$, 11kV winding $X_1 = X_2 = X_0 = j0.03 \text{ p.u.}$, 3.3kV winding $X_1 = X_2 = X_0 = j0.05 \text{ p.u.}$, all on a 10MVA base. Resistance may be neglected throughout.

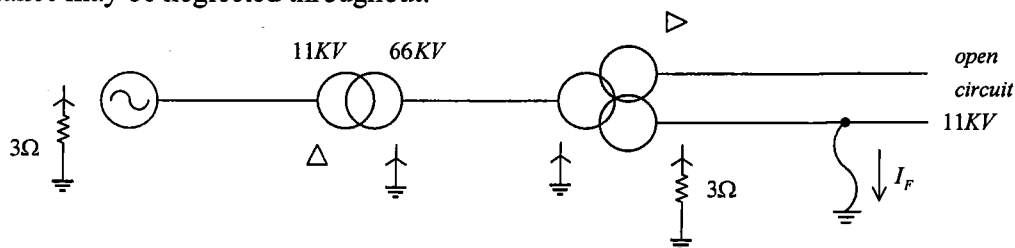


Fig. 2

參考用

注意:背面有試題

※請在答案卷內作答

四、(15%) 計算題:請詳列計算過程,無計算過程者不予計分。

As shown in Fig. 3, a 10kVA 3-phase balanced linear load with a power factor of $pf=0.8$ (lag) is connected to a 220Vrms, 60Hz utility grid. A conventional voltage source inverter is installed to provide reactive power compensation to reach unity power factor.

(一)、(9%) Calculate how much current the inverter needs to provide to reach the goal of unity power factor.

(二)、(6%) Assuming this inverter operates in sine-PWM mode in the range of linear modulation. What is the lowest DC bus voltage of this inverter?

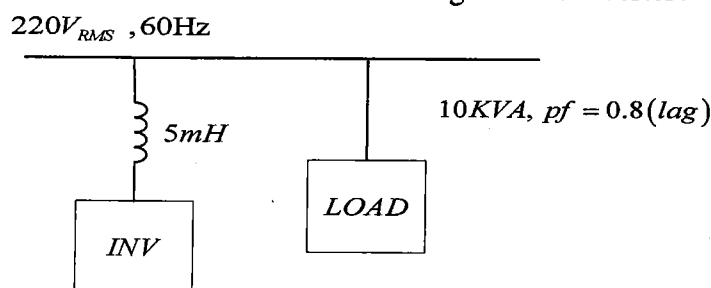


Fig. 3

五、(10%) 申論題:請提綱契領闡述以下題目。

Please illustrate the operational principle of the impedance (distance) relay for transmission line protections in power systems.

六、(10%) 計算題:請詳列計算過程,無計算過程者不予計分。

A three-phase 60 Hz isolated power system has the following characteristics: The load varies by 0.8 percent for 1 percent change in frequency. The governor speed regulation is set to 0.05 per unit. A sudden load increase of 0.1 per unit occurs. Find the steady-state frequency deviations in Hz.

七、(10%) 計算題:請詳列計算過程,無計算過程者不予計分。

The fuel-cost functions for three thermal plants in \$/h are given by

$$C_1 = 500 + 5.2P_1 + 0.003P_1^2; C_2 = 200 + 5.8P_2 + 0.008P_2^2; C_3 = 400 + 5.6P_3 + 0.006P_3^2;$$

where P_i , $i=1, 2, 3$ are in MW. The total load is 800MW. Neglecting line losses and generator limits, find the optimal dispatch and the total cost in \$/h.

八、(10%) 申論題:請提綱契領闡述以下題目。

Illustrate how to explore the equal-area criterion for transient stability assessment of the one-machine-infinite-bus power system.