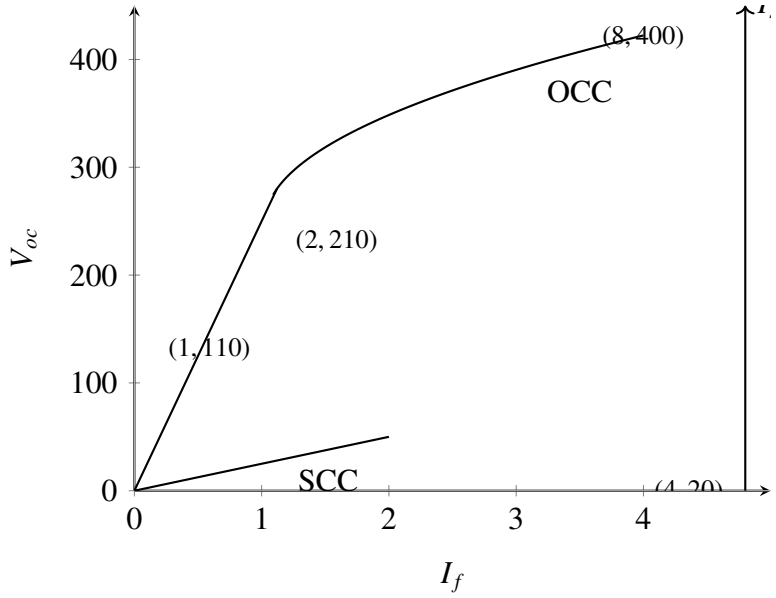
2020-EE-'40-52'

EE24BTECH11023

1) Let a_r, a_ϕ, and a_z be unit vectors along r, θ, and z directions, respectively, in the cylindrical coordinate system. For the electric flux density given by $\mathbf{D} = a_r 15 + a_\theta 2r - a_z 3rz$ Coulomb/m^2, the total electric flux, in Coulomb, emanating from the volume enclosed by a solid cylinder of radius 3 m and height 5 m oriented along the z-axis with its base at the origin is:
   a) $54\ \pi$
   b) $90\ \pi$
   c) $108\ \pi$
   d) $180\ \pi$
2) A stable real linear time-invariant system with a single pole at p, has a transfer function
$$H(s) = \frac{s^2 + 100}{s - p}$$
   with a dc gain of 5. The smallest positive frequency, in rad/s, at unity gain is closest to
   a) 8.84
   b) 11.08
   c) 78.13
   d) 122.87
3) The number of purely real elements in a lower triangular representation of a given 3×3 matrix, obtained through decomposition is _____.
$$\begin{bmatrix} 2 & 3 & 3 \\ 3 & 2 & 1 \\ 3 & 1 & 7 \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{12} & a_{22} & 0 \\ a_{13} & a_{23} & a_{33} \end{bmatrix} \begin{bmatrix} a_{11} & 0 & 0 \\ a_{12} & a_{22} & 0 \\ a_{13} & a_{23} & a_{33} \end{bmatrix}^\top$$
   a) 5
   b) 6
   c) 8
   d) 9
4) The figure below shows the per-phase Open Circuit Characteristics (measured in V) and Short Circuit Characteristics (measured in A) of a 14 kVA, 400 V, 50 Hz, 4-pole, 3-phase, delta connected alternator, driven at 1500 rpm. The field current, I_f is measured in A. Readings taken are marked as respective (x, y) coordinates in the figure.Ratio of the unsaturated and saturated synchronous impedances $(Z_{s(unsat)}/Z_{s(sat)})$ of the alternator is closest to:



a) 2.100
b) 2.025
c) 2.000
d) 1.000

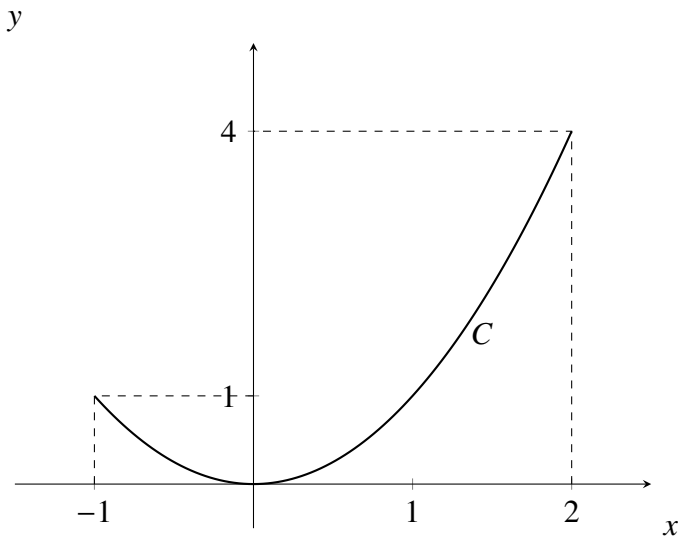
5) Let a_x and a_y be unit vectors along x and y directions, respectively. A vector function is given by:

$$\mathbf{F} = a_x y - a_y x$$

The line integral of the above function

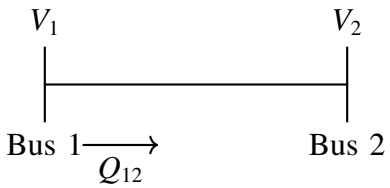
$$\int_C \mathbf{F} \cdot d\mathbf{l}$$

along the curve C, which follows the parabola $y = x^2$ as shown below is _____ (rounded off to 2 decimal places).

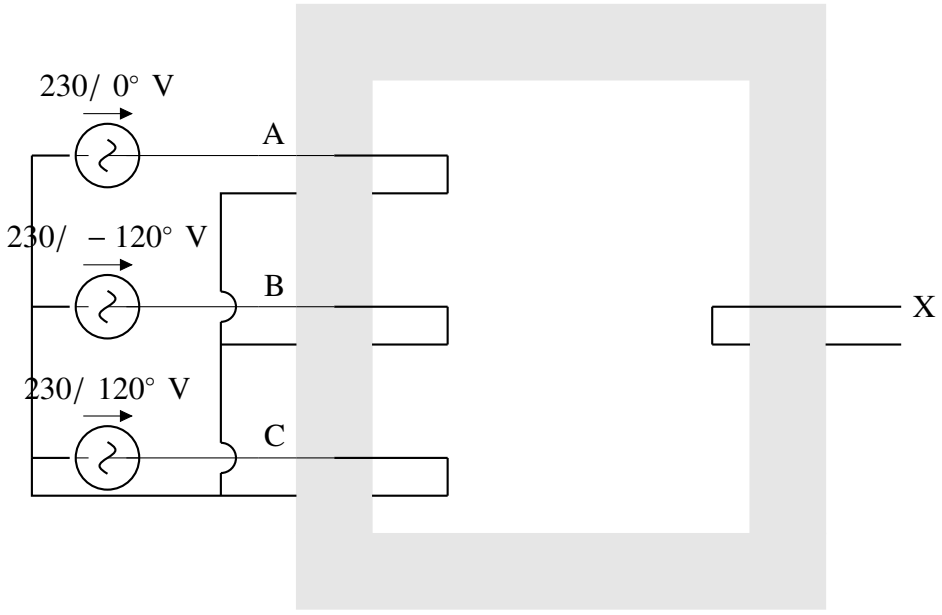


6) A resistor and a capacitor are connected in series to a 10 V dc supply through a switch. The switch is closed at $t = 0$, and the capacitor voltage is found to cross 0 V at $t = 0.4\tau$, where τ is the circuit time constant. The absolute value of percentage change required in the initial capacitor voltage if the zero crossing has to happen at $t = 0.2\tau$ is _____ (rounded off to 2 decimal places).

7) A cylindrical rotor synchronous generator with constant real power output and constant terminal voltage is supplying 100 A current to a 0.9 lagging power factor load. An ideal reactor is now connected in parallel with the load, as a result of which the total lagging reactive power requirement of the load is twice the previous value while the real power remains unchanged. The armature current is now _____(rounded off to 2 decimal places).
8) Bus 1 with voltage magnitude $V_1 = 1.1$ pu is sending reactive power Q_{12} towards bus 2 with voltage magnitude $V_2 = 1$ pu through a lossless transmission line of reactance X. Keeping the voltage at bus 2 fixed at 1 pu, the magnitude of voltage at bus 1 is changed, so that the reactive power Q_{12} sent from bus 1 is increased by 20%.Real power flow through the line under both the conditions is zero. The new value of the voltage magnitude, V_1, in pu (rounded off to 2 decimal places), at bus 1 is _____.



9) Windings 'A', 'B', and 'C' have 20 turns each and are wound on the same iron core as shown, along with winding 'X' which has 2 turns.The figure shows the sense (clockwise/anti-clockwise) of each of the windings only and does not reflect the exact number of turns. If windings 'A', 'B', and 'C' are supplied with balanced 3-phase voltages at 50 Hz and there is no core saturation, the no-load RMS voltage (in V, rounded off to 2 decimal places) across winding 'X' is _____.



10) A cylindrical rotor synchronous generator has steady state synchronous reactance of 0.7 pu and subtransient reactance of 0.2 pu. It is operating at $(1 + j0)$ pu terminal voltage with an internal emf of $(1 + j0.7)$ pu. Following a three-phase solid short circuit fault at the terminal of the generator, the magnitude of the subtransient internal emf (rounded off to 2 decimal places) is _____ pu.
11) In the dc-dc converter circuit shown, switch Q is switched at a frequency of 10 kHz with a duty ratio of 0.6. All components of the circuit are ideal, and the initial current in the inductor is zero. Energy stored in the inductor in mJ (rounded off to 2 decimal places) at the end of 10 complete switching cycles is _____.

12) A single-phase, full-bridge, fully controlled thyristor rectifier feeds a load comprising a 10 Ω resistance in series with a very large inductance. The rectifier is fed from an ideal 230 V, 50 Hz sinusoidal source through cables which have negligible internal resistance and a total inductance of 2.28 mH. If the thyristors are triggered at an angle $\alpha = 45^\circ$, the commutation overlap angle in degree (rounded off to 2 decimal places) is_____.
13) A non-ideal Si-based pn junction diode is tested by sweeping the bias applied across its terminals from -5 V to +5 V. The effective thermal voltage, V_T, for the diode is measured to be (29 ± 2) mV. The resolution of the voltage source in the measurement range is 1 mV. The percentage uncertainty (rounded off to 2 decimal places) in the measured current at a bias voltage of 0.02 V is _____.