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(a) The speed of rotation of this generator's shaft is

$$n_{\text{sync}} = \frac{120 f_{se}}{P} = \frac{120(50\text{ Hz})}{20} = 300\text{ r/min}$$

(b) The per-unit phase voltage at rated conditions is $\mathbf{V}_\phi = 1.0\angle 0°$ and the per-unit phase current at rated conditions is $\mathbf{I}_A = 1.0\angle -25.8°$ (since the power factor is 0.9 lagging), so the per-unit internal generated voltage is

$$\mathbf{E}_A = \mathbf{V}_\phi + R_A\mathbf{I}_A + jX_S\mathbf{I}_A$$
$$\mathbf{E}_A = 1\angle 0° + (0.1)(1\angle -25.8°) + j(0.9)(1\angle -25.8°)$$
$$\mathbf{E}_A = 1.69\angle 27.4°\text{ pu}$$

The base phase voltage is

$$V_{\phi,\text{base}} = 12\text{ kV}/\sqrt{3} = 6928\text{ V}$$

so the internal generated voltage is

$$\mathbf{E}_A = (1.69\angle 27.4°\text{ pu})(6928\text{ V}) = 11,710\angle 27.4°\text{ V}$$

(c) The torque angle of the generator is $\delta = 27.4°$.

(d) The base impedance of the generator is

$$Z_{\text{base}} = \frac{3\,V_{\phi,\text{base}}{}^2}{S_{\text{base}}} = \frac{3(6928\text{ V})^2}{200,000,000\text{ VA}} = 0.72\ \Omega$$

Therefore the synchronous reactance is

$$X_S = (0.9)(0.72\ \Omega) = 0.648\ \Omega$$

and the armature resistance is

$$R_A = (0.1)(0.72\ \Omega) = 0.072\ \Omega$$

(e) If the field current is held constant (and the armature resistance is ignored), the power out of this generator is given by

$$P = \frac{3V_\phi E_A}{X_S}\sin\delta$$

The max power is given by

$$P_{\max} = \frac{3V_\phi E_A}{X_S}\sin 90° = \frac{3(6928\text{ V})(11,710\text{ V})}{0.648\ \Omega} = 376\text{ MW}$$

Since the full load power is $P = (200\text{ MVA})(0.85) = 170\text{ MW}$, this generator is supplying 45% of the maximum possible power at full load conditions.

(f) At the maximum power possible, the torque angle $\delta = 90°$, so the phasor $\mathbf{E}_A$ will be at an angle of 90°, and the current flowing will be

$$\mathbf{E}_A = \mathbf{V}_\phi + R_A\mathbf{I}_A + jX_S\mathbf{I}_A$$

$$\mathbf{I}_A = \frac{\mathbf{E}_A - \mathbf{V}_\phi}{R_A + jX_S}$$

$$\mathbf{I}_A = \frac{11{,}710\angle 90° \text{ kV} - 6298\angle 0° \text{ kV}}{0.072 + j0.648\ \Omega} = 20{,}400\angle 34.6° \text{ A}$$

The impedance angle $\theta = -34.6°$, and the reactive power supplied by the generator is

$$Q = 3V_\phi I_A \sin\theta = 3(6298 \text{ V})(20{,}400 \text{ A})\sin(-34.6°) = -219 \text{ Mvar}$$