

ECE370 MACHINES & POWER

Review problems for Test 1

- Two 3ϕ loads are fed from a 60 Hz supply via two parallel feeders each with impedance $1.5 + j2 \Omega/\text{phase}$. Load 1 is Y-connected, 3.4 MW, 0.7 pf **lag** and Load 2 is Δ -connected, 4 MVA, 0.9 pf **lead**. The voltage at the load is 13.8 kV. Determine:
 - the real and reactive power of the combined loads,
 - the power factor of the combined loads, (0.9709 lag)
 - the percent voltage regulation when both feeders are in service, and
 - the percent voltage regulation when one feeder is out of service. (7.49%)
- A factory is supplied at 69 kV from a 3ϕ , 60 Hz supply. It draws a continuous load of 72 MW with a pf of 0.6 lag. Determine:
 - The reactive power rating (kVAR) and capacitance ($\mu\text{F}/\text{phase}$) of a Y-connected bank that will improve the pf to 0.96 lag. (75 MVAR)
 - The annual saving in demand charge, if the monthly demand charge is \$10.00/kVA. (5.4 M\$/yr)
 - The annual saving in energy charge, if the energy charge is 8 ¢/kWh and the feeder resistance is $1.5 \Omega/\text{ph}$.
- Two three-phase loads are supplied at 34.5 kV via a feeder rated at 540 A with an impedance of $0.78 + j3.9 \Omega/\text{phase}$. The first load is 15 MW @ 0.687 lag, and the second load is 25 MVA @ 0.8 lag. The line is found to be overloaded and it is decided that some load should be transferred to another feeder. Determine:
 - The % of the combined load current that should be transferred, so that the feeder will satisfy the rating given. (The pf of the load remains constant.)
 - The % voltage regulation after the load has been transferred. (8.78%)
 - The value of capacitance/phase of a Y-connected capacitor bank needed to improve the new load pf to 0.98 lag.
 - The % voltage regulation after the pf has been improved. (3.5%)
- Determine the necessary shaft speed (rpm) and torque (Nm) of a hydroelectric turbine that drives a 50 Hz, 32 pole synchronous generator, rated 22 MW if the generator's rated efficiency is 90%. (187.5 rpm, 1.25 MNm)
 - The governor of a 60 Hz, 4 pole turbo-alternator is set at 1746 rpm. Determine the percent error in the developed frequency. (3%)
- One of the powerhouses of a hydroelectric development has three penstocks, each has 8 m diameter and passes $600 \text{ m}^3/\text{s}$ of water with velocity 35 m/s when the average head behind the dam is 75 m. The generators operate at 0.95 lag pf and the electricity is transmitted at 230 kV.
 - Calculate the penstock efficiency. (83.25%)
 - Assuming the coefficient of performance of the turbine is $\frac{2}{3}$ and the generator efficiency is 90.1%, what is the generated electrical power for the powerhouse?
 - Calculate the magnitude of the current in the transmission lines. (1.75 kA)