Problem 1: Three, single-phase voltage regulators are being installed in a wye configuration on a three-phase distribution line with a nominal line-to-line voltage of 12.47kV. The CTs (current transformers) have a ratio of 100:5. The PTs (potential transformers) are connected line-to-neutral and have an output of 120V at nominal primary system voltage. The regulation point is 5.0 miles beyond the regulators. The resistance of the distribution conductor is 0.23 ohms/mile, and the inductive reactance is 0.42 ohms/mi. Assume the feeder is three-phase and relatively balanced to the end of the feeder.

(20 pts) Calculate initial settings for R and X for the line-drop compensators in these regulators.

Problem 2: A certain 12.47kV line-to-line distribution feeder is served from a load-tap-changing transformer in the substation, and has two voltage regulators in series at approximately 1/3 and 2/3 of the distance between the substation and the end of the feeder. The regulators are both typical, 32-step regulators like those discussed in the text and in lecture 27. This feeder also has one 600kvar capacitor bank installed beyond the second regulator, i.e., there are two regulators between the substation and the capacitor. System inductive reactance is 6.7 ohms upstream of the capacitor bank.

Assume voltage at the substation bus remains at 121V on a 120V base regardless of feeder loading. The feeder primarily serves irrigation pumps. There is a trip-close of the feeder circuit breaker at the substation which causes most of the feeder load to trip off. The remaining feeder load is negligible. Immediately prior to the trip-close, the capacitor described above was on, one regulator was at step +12, and the other was at step +11.

(20 pts) Estimate the maximum RMS voltage on a 120V base at the end of the feeder, beyond both regulators and the capacitor following the trip-close of the feeder's circuit breaker.

Problem 3: Three 400kW, 3-phase, motors are served from a 1500kVA, 480V (line-to-line) transformer. The impedance (Z) of the transformer is 5.4%. The displacement power factor of the running motors is 85% (lagging). A capacitor bank is to be installed adjacent to the three motors to improve the displacement power factor seen from the transformer source.

a) (10 pts) What is the size of the capacitor bank required (in kvar) so that the combined displacement power factor of the motors and capacitor bank is at least 93% but not more than 95%? The minimum individual capacitor size is 25kVAR on each phase.
b) (5 pts) What is the approximate percent voltage rise associated with this capacitor bank?
c) (5 pts) What is the approximate percent reduction in losses associated with this capacitor bank?

Problem 4: At an ASD, the angle between the fundamental voltage and fundamental current phasors is 9 degrees, and the voltage leads the current. The THD of the current is 33%. The THD of the voltage is negligible. For this ASD:

a) (5 pts) Calculate the displacement power factor.
b) (5 pts) Calculate the distortion power factor.
c) (5 pts) Calculate the true power factor.

Problem 5: A customer's air-conditioner starts 3 times per hour. The air conditioner is 240V and draws a peak RMS current of 130A when it starts. The customer is served with a 15kVA transformer and 50 feet of #2 aluminum service cable. Using the plots of transformer and service cable voltage drop from lecture 26, determine the following:

a) (5 pts) What is the expected percent voltage drop when the air conditioner starts?
b) (5 pts) What is the voltage drop in volts on a 120V base when the air conditioner starts?
c) (10 pts) Select a new transformer size, new service conductor size, or both, which will reduce the flicker below 4%. List your new transformer and/or servcie conductor sizes.
d) (5 pts) What is the new expected percent voltage drop following your changes in part (c) above?