PSCAD Coursework Handout

Rubric:

(1) ANSWER ALL SIX QUESTIONS.
(2) THE QUESTIONS ARE NOT EVENLY WEIGHTED
(3) UPLOAD YOUR ASSIGNMENT TO TURNITIN

Question 1. Diode bridge circuit

Go to master library and find single phase AC source, set it to 100V 60Hz. Set the source ramp up time to 0. Go to HVDC, FACTS & Power electronics to find diodes. Remove the snubber circuit. Set the simulation duration to 0.1 seconds. Build up the diode bridge as shown in Figure 1. Set the capacitor value to 5mF.

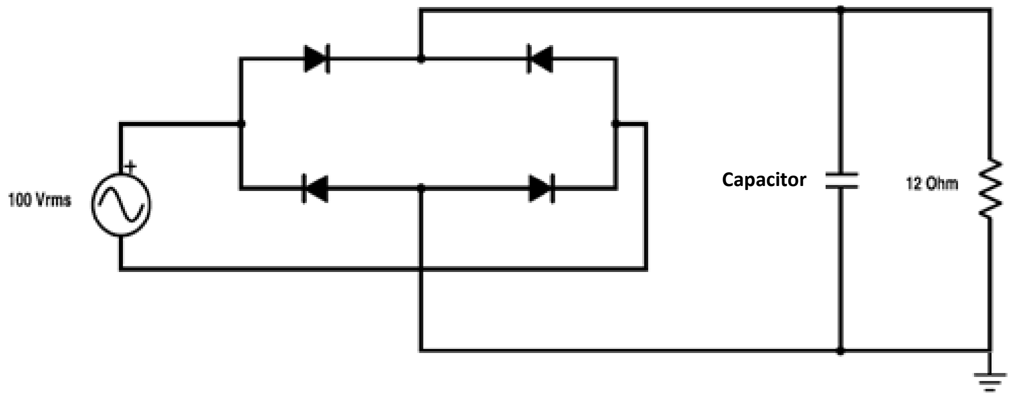

Figure 1 - Diode Circuit Bridge

1. Upload a screen capture of your circuit diagram from PSCAD, make sure relevant parameters are clearly visible (2 marks)

2. Measure the instantaneous input voltage across the voltage source and the instantaneous output voltage across the resistive load. Upload an image of the two graphs. (4 marks)

3. Discuss the purpose and effect of changing the capacitor to 25 mF (max. 100 words). (4 marks)

Question 2. Equivalent transformer

Build an equivalent transformer as shown in Figure 2. Set the transformer power to 120MVA. Set the system frequency to 60Hz. Set the load to 500 Ohm resistive load. Add a multi-meter to measure the voltage and phase angle across the load.

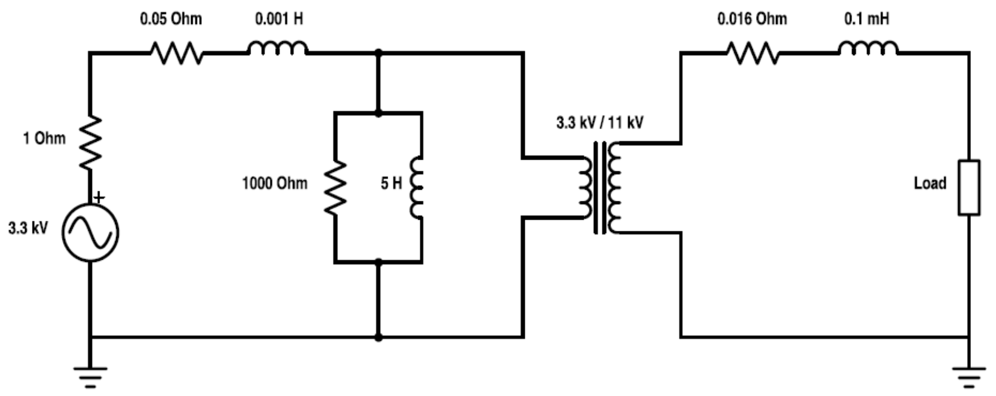

Figure 2 - Equivalent Transformer

a. Upload a screen capture of your circuit diagram from PSCAD, make sure relevant parameters are clearly visible. (2 marks)

b. Measuring across the load, what is the:
   a. RMS voltage (1 mark)
   b. Power factor (1 mark)

c. Change the load to a 0.01 H inductor, what is the:
   a. RMS voltage (1 mark)
   b. Power factor (2 marks)

d. Change the load to a 10 mF capacitor, what is the:
   a. RMS voltage (1 mark)
   b. Power factor (2 marks)

Question 3. Faulted 3-phase network (1)

The line diagram in Figure 3 shows a simple distribution network. A 3 phase 100 MVA 6 kV 50 Hz star connected grounded generator having negligible source impedance, supplies a no-loss 6kV:33kV delta-wye connected transformer (also rated at 100 MVA and grounded on the high voltage side) which in turn supplies a 3 phase load in each phase, identical having 7.5 Ω resistance and 17 mH inductance.

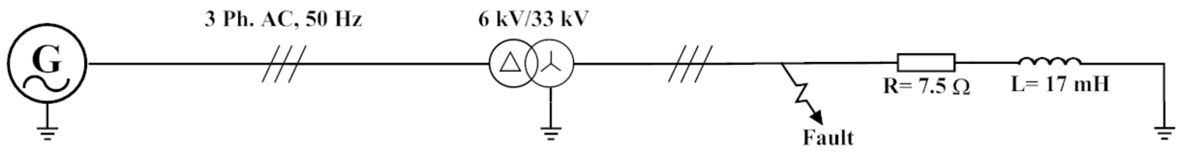

Figure 3 - Line Diagram of Distribution Network

A fault occurs on the high voltage side as shown in Figure 3. The fault is double-line-to-ground fault on phase A and B and occurs at 0.5 seconds for 0.05 seconds, after which the fault is presumed to have cleared. Construct the distribution network described above for a steady state 1 second duration simulation.

1. Upload a screen capture of your circuit diagram from PSCAD, make sure relevant parameters are clearly visible (2 marks)
2. Upload a screen capture showing the plotted results of the voltage and current waveforms before, during, and after the fault occurs. Make sure it is presented to a readable scale. (2 + 2 marks)
3. Discuss the observed phenomena in the faulted waveforms (max. 100 words) (4 marks)

Question 4. Faulted 3-phase network (2)

The same circuit as that in Question 3 now undergoes a different fault. Figure 4 below shows the current and voltage waveforms before, during, and after the fault.

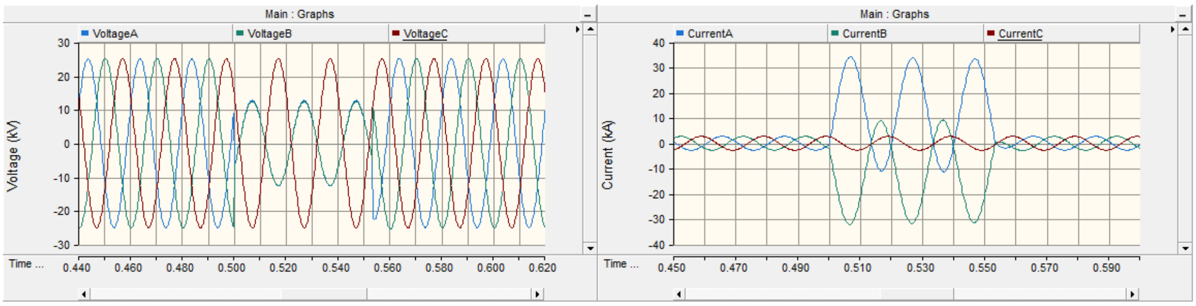

Figure 4 - Faulted Voltage and Current Waveforms

1. From the waveforms, suggest what type of fault has occurred, provide justification for your suggestion (max. 200 words) (6 marks)

2. In the circuit from Question 3, place a breaker between the transformer and fault. Build a system within the circuit to represent the breaker activating. Note that the system should react to the fault current rather than be manually controlled (i.e. not using timed logic). Add a screenshot of your circuit and any other suitable screenshots, explaining its operation. (max. 200 words) (4 marks)

Question 5. Faulted 3-phase network (3)

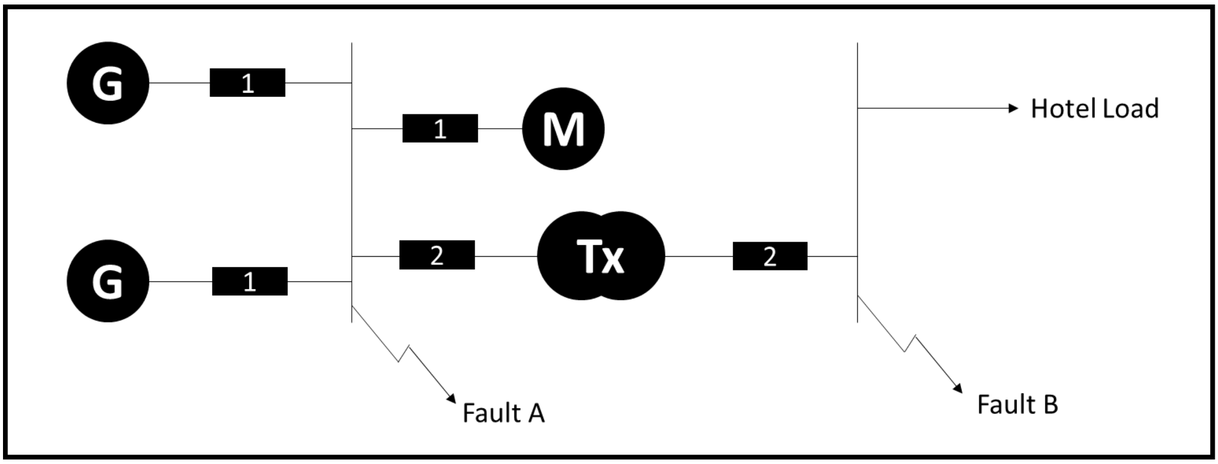

Figure 5 – Circuit Diagram

Generators (star-connected)		
Apparent power	12.5	MVA
Reactance	13	%
Voltage	3.3	kV
Frequency	50	Hz
Motor		
Apparent power	10	MVA
Reactance	28	%
Voltage	3.3	kV
Step-down transformer		
Apparent power	750	kVA
Resistance	2.1	%
Reactance	1.3	%
Turns ratio	7.5	-
Frequency	50	Hz
Cable impedance (1)		
Resistance	0.2	Ω
Reactance	0.45	Ω
Cable impedance (2)		
Resistance	1.2	Ω
Reactance	2.2	Ω

Table 1 – Equipment Characteristics

Figure 5 shows a circuit diagram for a system comprising two generators, one motor, one transformer, and cable impedances (represented by ‘1’ and ‘2’). The equipment characteristics are detailed in Table 1.

Calculate the fault level and fault current if a fault were to occur at location ‘Fault A’ and then at location ‘Fault B’ (the faults do not occur simultaneously). You must show your workings. (10 marks)

Question 6. Faulted Network Analysis

You have now used PSCAD to carry out fault analysis for a relatively simple system. Consider the following scenario:

> Your company is installing stand alone supply systems in remote areas not accessible to a distribution grid. These supply systems can be powered by wind, solar, geothermal or a combination of these sources. Your team has been given the task to determine the protection breaker ratings for the transmission line between the supply step up transformer and the low voltage distribution bus at the load end. Each source system is of the same basic design configuration but differ in terms of component specification and load capacity.

The design specification requires the following:

- A breaker at the HV side of the supply end transformer.
- Breakers at both the HV and LV sides of the distribution end transformer with the LV breaker being between the distribution end transformer and the distribution bus.
- Both transformers will be star – star with only the HV windings grounded.
- A bus interconnector between the main supply and a battery back up unit that is charged via the supply bus.
- If a fault occurs on the main supply the bus interconnector will open and the battery back up unit will provide emergency power to critical loads.

1. Draw a circuit diagram for the system, showing all the locations that you would select to measure potential fault currents and explain why you have chosen those particular locations. **Assume the resistive component of all impedances to be negligible. (10 marks)**
2. Build an Excel Spreadsheet tool that can be used by the field engineers to determine any modifications that are necessary to the breaker design, should they measure different final impedance values to those assumed during system design. The tool will be valid for a single fault location in the system (of your choosing) and will calculate line-to-line, single-line-to-ground, and double-line-to-ground faults, based on the amended measurements. You can assume all per unit values are to the same reference bases. The tool must be user-friendly, an instruction manual may be included if you wish and will not be included in your final word count for this question. **(20 marks)**

(Max 1000 words)