Examination Feedback for
EEE338 – Power Engineering – see questions A1–A4 and B1–B4
EEE341 – Electrical Power Systems – see questions A1–A4
EEE301 – Power Systems Engineering – see questions B1–B4
Spring Semester 2014-15

Feedback for EEE338 / EEE341 / EEE301 Session: 2014-2015

General Comments:

The main problem in this exam was students failing to show sufficient working and intermediate steps meaning it was difficult to award part marks if the final answer was incorrect. This is particularly important with diagrams. There were also a number of problems associated with conversion from complex to polar form and vice-versa (see comments under Q1 below). Repeatedly in lectures I mentioned it is worth spending a few pounds and getting a calculator that can handle this correctly and also save you time in performing the calculations.

Several candidates achieved very high marks, but there were a similar number who failed to make the pass mark and it is quite clear that the latter did not spend anywhere near enough time on independent study and practice. You should be spending about 5 hours per module per week outside lectures and then seeking help with any problems that you encounter. The attendance at lectures, particularly towards the end of semesters, was poor. There are several aspects of this module that you will not understand simply by reading through the lecture notes – you need to come to lectures to have it explained.

Some candidates only answered 4 rather than 5 questions – it is not clear whether they ran out of time or failed to read the instructions on the front page. This year most candidates completed the front cover to indicate which questions had been attempted – an improvement on previous years. However there still a few candidates who did not – this puts the marker in a bad mood as they have to go through the script to check. A marker in a bad mood may not be as generous in their giving of marks!

Question A1:

Attempted by approximately 75% of candidates. Part (a)(i) requested the use of the star-delta transformation, but in practice almost all candidates opted to use Millman's theorem because this was what appeared on the last couple of exams! Provided this was applied properly only ½ mark was deducted. (Note when using Millman's theorem it is usual to take the phase voltage V_{AN} as reference, whereas for the star-delta method the line voltage V_{AB} is taken as reference. This means when comparing answers for the 2 methods the magnitudes of voltages and currents are the same but there is a 30˚ phase shift for the phase angles). There were a lot of careless errors: incorrect transposition of values, missing signs or decimal places when converting between complex and polar format etc. (Get a decent calculator that saves you the effort and eliminates some of these problems!).

Hardly any candidates scored full marks for part (b)(i) as they missed the voltages across the wattmeter coils off the diagram. The voltage across W1 is the voltage across R_A so is in phase with I_A; the voltage across W2 is V_{CB} (not V_{BC}) which led to mistakes in part (b)(ii). Part (c)(i) had similar problems with many candidates incorrectly describing where to connect the voltage coil of W1 –it should be connected to the phase without any current measuring coils, in this case phase B to measure V_{AB}. Many students also incorrectly wrote the current for W2 as I_B rather than looking at the figure and realizing its current coil is in phase C. This is a classic case of memorising past exams rather than understanding the principles for which marks were (rightly!) lost. In part (c)(ii) most candidates knew the correct method, but some confused resistance and impedance. Most candidates answered part (c)(iii) correctly.

Question A2:

Attempted by approximately 88% of candidates. Part (a) was pure bookwork but was completely ignored by many candidates. Of those that did attempt it diagrams were very poor and description was often non existent – a diagram without explanation is virtually worthless. Most candidates made a reasonable attempt at part (b) but often missed the second part; this may have been because it was not requested on some past papers – read the question, don't assume it will be the same as past exams. Generally part (c)(i) was answered correctly by most candidates, but several only worked out the pu fault level (not the actual fault level) or the fault current instead – again read the question! Also in part (c)(ii) many candidates quoted the pu fault level (rather than the actual value) or omitted to calculate the currents through each of the circuit breakers – again read the question! Also in this part a number of candidates decided to multiply the line reactance by 3 – I have no idea why; I have never seen this before and it is totally wrong. For part (c)(iii) the most common mistake was to try and apportion a fraction of the actual fault current calculated for circuit breaker D; you need to use pu values here as the base current of the generator is different to the base current of the busbar B (in theory you could use the actual current but you would have to reflect it back across transformers T3 and T1, negating the whole reason for the pu system). Very few candidates attempted part (c)(iv) and even fewer gained the correct answer; a common fault was to assume the reactor replace the line and/or T3; it is in addition to these.

Question A3:

Attempted by approximately 55% of candidates. Parts (a)(i) and (ii) were bookwork. A few candidates gave near perfect answers but the majority did not include anywhere near enough explanation. Part (a)(iii) was extremely poorly answered with only a handful of candidates correctly drawing the phasor diagrams. It was obvious that most candidates had simply tried to memorise the diagrams without understanding their derivation/construction which led to a multitude of mistakes. Most candidates correctly quoted the equation for a machine acting as a motor but then proceeded to draw phasor diagrams for a generator (or even a mixture of the two!). First draw *V* as reference and then the current I (either lagging, leading or in phase with *V* depending on which diagram you are drawing). The IR phasor is always parallel to I and either adds to *V* (generator) or subtracts from *V* (motor). The jIX phasor is always at 90˚ to IR (rotated in and anticlockwise direction). Many of the mistakes in part (b) stemmed from confusion between apparent power,*S*, (VA) and real power, *P*, (W) – remember *P* = *S* x power-factor – this is 1st year stuff you should know off by heart. Another mistake was to forget the minus sign for the phase angle of the current; the 'lagging power-factor' should tell you this – again basic fundamental stuff. Notwithstanding the errors just mentioned, most candidates made a reasonable attempt at part (b)(i) but many missed calculating the regulation – again read the question! In part (b)(ii) the question states the power increases so you cannot use the value of power from part (i); the current also increases. Since the p.f. = 1 the jIX phasor is at 90˚ to V and pythagarus can be applied to the phasor diagram to find IX and hence I, and the load angle. Part (iii) is a little more involved as you need to find the magnitude of the current, the phase angle of the current and the new load angle. First find the load angle using the fact that: $P_{Phase} = \frac{VE\sin(\delta)}{X}$ but remember this is per phase, i.e. you need to convert the given 8MVA to real power (6MW) and then divide by 3 for the real power per phase (2MW), then find the magnitude and phase of the current by rearranging the generator equation.

A number of candidates used 11kV (instead of 50kV) and 6Ω (instead of 8Ω) which were values used in similar questions in past exams. Unfortunately you are sitting this exam not a past paper!

Question A4:

Attempted by approximately 30% of candidates. Parts (a) and (b) were pure bookwork, but again most students did not provide sufficient explanations. In part (b) the question specifically asks for phasor diagrams – often these were either omitted or not labeled and I gained the impression that the majority of candidates were trying to do these from memory rather than working them out from first principles. In part (c) the main error was candidates forgetting the complex conjugate or failing to convert the reactances to the same base. When adding the in-line reactor in part (d) its value is determined by making the pu impedances of each branch the same on the transformer's own MVA base, not the common base. (if the common base is used it will be find that the load is shared equally and not in the ration of the transformer's ratings). Only a couple of candidates attempted part (e) which was surprising as apart from calculating the overall MVA rating (1st year stuff) the procedure is identical to parts (c)(i) and (d)(ii).

Question B1:

Attempted by approximately 50% of candidates. Part (a) was standard bookwork and most candidates made a reasonable attempt at this. In the main parts (b)(i),(ii) and (iii) were correctly answered with only a few minor calculation mistakes. For part (b)(iv) the quality of sketches left a lot to be desired; in some cases they were so untidy it was difficult to make out which areas had been shaded to indicate the accelerating and decelerating areas (deliberate?), and often candidates omitted to indicate the mechanical power line and/or the critical load angle. For those candidates who attempted part (b)(v) the majority did this successfully, although a couple of candidates used degrees rather than radians for the $P_m\delta$ calculations or used radians when their calculator was set to degrees for the cos(δ) calculations. In part (c) a common error was to forget to take the average of the accelerating power at the switching instant, although this had been done correctly at time zero. Remember to state whether the system remains stable or not.

Question B2:

Attempted by approximately 94% of candidates. Most candidates made a reasonable attempt at part (a), however many forgot to account for the voltage mismatch between *G3* and *T3* and some did not notice that the line reactances were given in Ohms and need converting to pu values. Many candidates correctly performed this task, however they used the same impedance base when performing the conversion on the earthing resistor – *G2* operates at 25kV whereas the lines are at 132kV i.e. different impedance base. In part (b) the most common mistake was errors in transposing the values calculated in part (a); another common problem was to make mistakes in reducing the initial circuit to a single impedance value because the position of the fault was omitted – always include this on all diagrams. Some candidates included the earthing reactor in the positive and negative sequence diagrams and/or omitted it from the zero sequence diagram – remember it only appears in the zero sequence diagram, and remember the x3 factor. Most candidates knew the correct method for part (c) even though they may have had incorrect values – always state the equations you are using then at least you will receive some marks for procedure. Many candidates chose to skip part (d), and few who attempted it obtained the correct answer – you need to work out the fraction of the sequence currents that flow through CB and then the actual fault current. Also be careful to answer the question that is asked. In this question the fault current is 2920A and the CB is set to trip at 2500A – i.e. it will trip for any current greater than 2500A so here it is adequate.

<u>Question B3</u>:

Attempted by approximately 40% of candidates. This is a highly descriptive question based on bookwork. Part (a) was generally answered well although a number of candidates only gave the source of short circuits and did not explain why protection is needed, or vice-versa –read the question! The need to read the question was clearly evident for part (b)(i) where several candidates sketched a diagram of the main components of a protection system, which appeared on a previous exam, and not the main components of an induction relay – read the question! Many candidates included diagrams, which are very useful, but If you use a diagram to illustrate a point then make sure it is legible and labeled – a diagram with no labels is often meaningless. For part (b)(ii) it is important to state that in a Buccholz relay there are two sets of contacts (mercury tilt switches), one acts when there is a slow build up of gas in the relay housing and activates the alarm, the other acts when there is a major inrush of gas following a major fault and activates tripping out of the transformer. This inrush of gas impinges on the bucket or vane of the trip contacts so these should be drawn close to the oil pipe leading from the transformer. Part (c) was generally well answered and many candidates gave near perfect rendition of the course notes. Hardly any candidates attempted part (d). In a couple of cases it was stated that the current transformer should not be operated without a load because high currents would flow and damage the transformer – if there is no load then there is no circuit and no current can flow.

<u>Question B4</u>:

Attempted by approximately 42% of candidates. Part (a) was omitted by almost all candidates despite hints being given that certain proofs make popular exam questions! In part (b) many candidates knew the correct procedure, but treated all 7 conductors the same – the central conductor has equal distances to all the others which is not true of the other conductors. Several candidates wrote down lengthy equations (some of which were incorrect) and somehow achieved the answer given in the exam paper! You need to show detailed working in a question like this. The biggest problem in part (c) was candidates providing a value for the inductance per metre, but not the reactance per kilometre as requested – read the paper! In (c)(i) many candidates took the GMR as 4mm instead of the correct value of 0.7788 x 4mm and some used the square root, rather than the cube root, when calculating the GMD. Most candidates made a good attempt at parts (d) and (e).