EEE349 and EEE350 Power Engineering Electromagnetics

Finite element assessment 2014/15

Each question contains a series of references to parameters (**CAPITAL BOLD UNDERLINED AND HIGHLIGHTED IN GREY**) in the text or parameters defined on accompanying figures. Please consult Appendix A to get your individual values for these parameters.

You should complete the assignment on the answer pro-forma supplied and e-mail this to:

eee349assessment@sheffield.ac.uk

You should include the following as attachments:

1. The answer sheet – either as completed WORD document or a scanned pdf of a handwritten sheet.
2. A working model file for both questions. Label these Q1 and Q2. Clearly you may have adapted your models for different currents, positions etc. You need only send one version for each question, which for example might be the last one you used. You do not need to provide an explanation of which particular version you have sent.

The deadline for submission is Friday March 20th 2015

E-mail submissions with a date of March 20th (i.e. up to midnight) are acceptable. Please retain your sent-mail saved message as proof of submission. If you miss the deadline, please submit as soon as possible thereafter to minimise the extent of the late submission penalty. A notification that you are late but still intend to submit will be useful.

A series of 10 minute individual viva sessions will be held in April to check your understanding of the problems (timings are schedules will be available nearer the date).

Q1. A 50Hz, **Q1VOLT** KVrms (line to line) three-phase , dual-circuit overhead transmission line is suspended between a series of **Q1PYLON** design pylons.

i) Calculate the maximum **electrical** field strength **and magnetic** field strength 1m above the ground if the system is delivering a power of **Q1POWER** MW at a power factor of **Q1POWFAC** lagging (this power is the total for both circuits on the pylon).

ii) Calculate the effective capacitance to ground of each of the three phases.

You can obtain pylon dimensions from:
http://www.emfs.info/Sources+of+EMFs/Overhead+power+lines/Calculating/geometries/

- You may assume that the two sides of the pylon are geometrically and electrically symmetrical.
- If some dimensions are not listed for your pylon and lines, then you may scale from the typical drawing of a representative pylon

- You may approximate the array of conductors which make up each line in practice (often 2 or 4) as a single conductor carrying the same overall current
- You should list any assumptions that you make regarding the location and time instant at which the maximum electric and magnetic field 1m above the ground is achieved
- List approximations that you make for pylon and line dimensions not fully specified in the National Grid data.

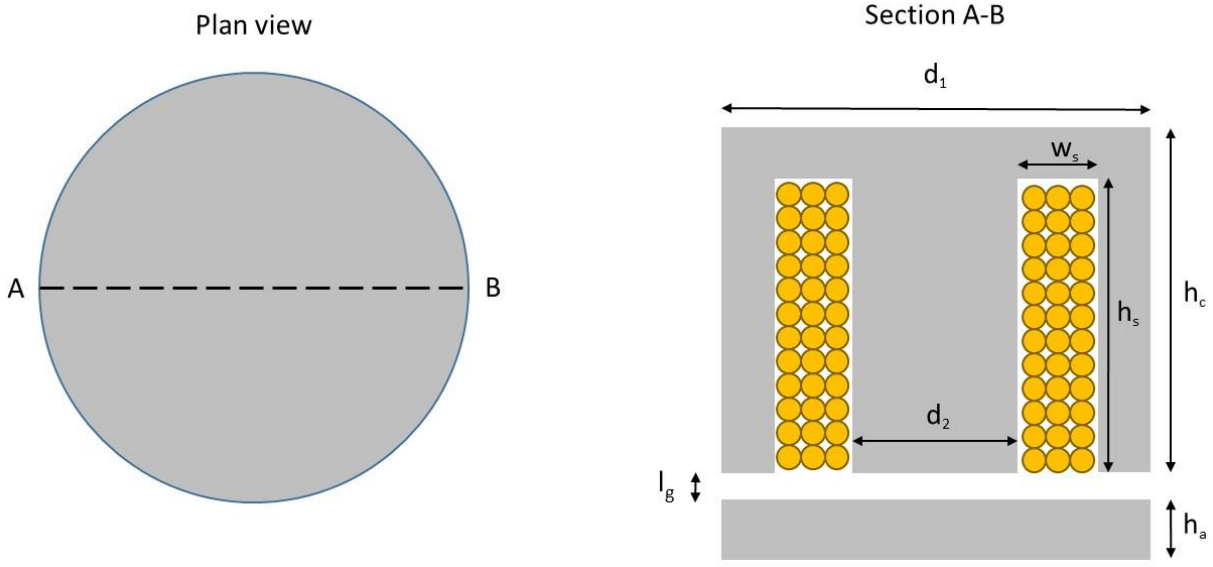
Q2. The figure below shows an axisymmetric cylindrical linear actuator in which the moving armature is drawn towards the stator when current is flowing in the coil. The armature moves over a stroke of 3mm from the fully close position (l_g=0) to l_g=3mm. The coil in the slot has a packing factor of 0.6. The stator and armature cores are manufactured from Hiperco 50 which is one particular grade of Cobalt Iron (non-linear magnetisation curve in the FEMM materials database).

Using the dimensions listed in the parameter table, calculate the following:

i) The variation in force as a function of airgap across the full stroke (you should calculate the force with at least 5 intermediate points) with a DC current density in the copper conductors of 5A/mm^2. Plot a graph on your answer sheet with your data

ii) The current density in the copper conductors required to increase the force at the mid-point of the stroke by a factor of 3 compared to the corresponding value obtained with a DC conductor current density of 5A/mm^2.

iii) Calculate the inductance of the actuator for a DC current density in the copper conductor of 1A/mm^2 for value of l_g=0 and l_g = 3mm.



dAppendix A

Q1.

			Q1VOLT (kV rms)	**Q1PYLON** design	**Q1POWER** (MW)	**Q1POWFAC** all lagging
1	Abdullah	Al Kalbani	400	L6	400	0.8
2	Ahmad	Albustami	400	L6	600	0.75
3	Turab	Ali	400	L6	750	0.85
4	Amirul Rafiq	Baharul Razi	400	L6	500	0.92
5	David	Baughan	400	L6	820	0.9
6	Umi Syahirah	Binti Azhar	400	L6	540	0.91
7	Fatin	Binti Saad	400	L6	790	0.88
8	Thomas	Cato	400	L6	910	0.82
9	Wan Ting	Chan	275	L6	275	0.85
10	Bozhong	Chen	275	L6	300	0.9
11	Runan	Chen	275	L6	380	0.87
12	Abhimanyu	Chopra	275	L6	360	0.86
13	Arthur Tee Lee	Foo	275	L6	420	0.86
14	Yunhao	Feng	275	L6	460	0.83
15	Jianyu	Hao	275	L6	295	0.95
16	Ammar	Hassan	400	L2	390	0.91
17	Edi	Herman	400	L2	620	0.85
18	Mengran	Huang	400	L2	710	0.94
19	Ting	Huang	400	L2	490	0.86
20	Amir Aizuddin	Jamaludin	400	L2	780	0.81
21	Nurul Raihanah	Jamel	400	L2	900	0.97
22	Ammar	Jamil	400	L2	820	0.86
23	Bakytnur	Kassenbay	400	L2	790	0.87
24	Hong Shen	Lim	275	L2	305	0.82
25	Heqing	Lu	275	L2	280	0.93
26	Yunhai	Lu	275	L2	395	0.89
27	Jean	Mananga	275	L2	400	0.87
28	Saqib	Moosa	275	L2	380	0.85
29	Mehmet	Nazif	275	L2	360	0.89
30	Yeh	Ong	275	L2	440	0.93
31	Aden	Precious	400	L12	400	0.91
32	Otis	Rook-Grignon	400	L12	600	0.9
33	Hassan	Shah	400	L12	750	0.88
34	Bufan	Song	400	L12	500	0.83

35	Petru	Tarabuta	400	L12	820	0.92
36	Hao	Wang	400	L12	710	0.87
37	Chengzhi	Wu	400	L12	905	0.86
38	Yue	Xuan	400	L12	650	0.82
39	Xin	Yi	275	L12	315	0.88
40	Georgios	Yiannakou	275	L12	270	0.92
41	Qijun	Yuan	275	L12	410	0.94
42	Yafeng	Zhang	275	L12	430	0.89
43	Bin	Zhao	275	L12	380	0.79
44	Zikryya	Rana	275	L12	360	0.87
45	SPARE		275	L12	315	0.85
46	SPARE		275	L12	280	0.92
47	SPARE		400	L12	700	0.84
48	SPARE		275	L2	390	0.87

Q2. All dimensions in the table below are in mm

			d_1	d_2	w_s	h_s	h_c	h_a
1	Abdullah	Al Kalbani	34.4	20.0	4.0	25.0	30.5	6.5
2	Ahmad	Albustami	35.2	20.0	4.5	22.2	27.7	6.5
3	Turab	Ali	36.1	20.0	5.0	20.0	25.5	6.5
4	Amirul Rafiq	Baharul Razi	36.9	20.0	5.5	18.2	23.7	6.5
5	David	Baughan	37.7	20.0	6.0	16.7	22.2	6.5
6	Umi Syahirah	Binti Azhar	38.6	20.0	6.5	15.4	20.9	6.5
7	Fatin	Binti Saad	41.4	25.0	4.0	25.0	31.9	8.1
8	Thomas	Cato	42.2	25.0	4.5	22.2	29.1	8.1
9	Wan Ting	Chan	43.0	25.0	5.0	20.0	26.9	8.1
10	Bozhong	Chen	43.8	25.0	5.5	18.2	25.1	8.1
11	Runan	Chen	44.7	25.0	6.0	16.7	23.5	8.1
12	Abhimanyu	Chopra	45.5	25.0	6.5	15.4	22.3	8.1
13	Arthur Tee Lee	Foo	48.4	30.0	4.0	25.0	33.3	9.8
14	Yunhao	Feng	49.2	30.0	4.5	22.2	30.5	9.8
15	Jianyu	Hao	50.0	30.0	5.0	20.0	28.3	9.8
16	Ammar	Hassan	50.8	30.0	5.5	18.2	26.4	9.8
17	Edi	Herman	51.6	30.0	6.0	16.7	24.9	9.8
18	Mengran	Huang	52.4	30.0	6.5	15.4	23.6	9.8
19	Ting	Huang	51.9	32.5	4.0	25.0	33.9	10.6
20	Amir Aizuddin	Jamaludin	52.7	32.5	4.5	22.2	31.2	10.6
21	Nurul Raihanah	Jamel	53.5	32.5	5.0	20.0	28.9	10.6
22	Ammar	Jamil	54.3	32.5	5.5	18.2	27.1	10.6
23	Bakytnur	Kassenbay	55.1	32.5	6.0	16.7	25.6	10.6

24	Hong Shen	Lim	55.9	32.5	6.5	18.5	27.4	10.6
25	Heqing	Lu	55.4	35.0	4.0	30.0	39.6	11.4
26	Yunhai	Lu	56.2	35.0	4.5	26.7	36.3	11.4
27	Jean	Mananga	57.0	35.0	5.0	24.0	33.6	11.4
28	Saqib	Moosa	57.8	35.0	5.5	21.8	31.4	11.4
29	Mehmet	Nazif	58.6	35.0	6.0	20.0	29.6	11.4
30	Yeh	Ong	59.4	35.0	6.5	18.5	28.1	11.4
31	Aden	Precious	59.0	37.5	4.0	30.0	40.3	12.2
32	Otis	Rook-Grignon	59.7	37.5	4.5	26.7	37.0	12.2
33	Hassan	Shah	60.5	37.5	5.0	24.0	34.3	12.2
34	Bufan	Song	61.3	37.5	5.5	21.8	32.1	12.2
35	Petru	Tarabuta	62.1	37.5	6.0	20.0	30.3	12.2
36	Hao	Wang	62.9	37.5	6.5	18.5	28.8	12.2
37	Chengzhi	Wu	62.5	40.0	4.0	30.0	41.0	13.0
38	Yue	Xuan	63.3	40.0	4.5	26.7	37.7	13.0
39	Xin	Yi	64.0	40.0	5.0	24.0	35.0	13.0
40	Georgios	Yiannakou	64.8	40.0	5.5	21.8	32.8	13.0
41	Qijun	Yuan	65.6	40.0	6.0	20.0	31.0	13.0
42	Yafeng	Zhang	66.4	40.0	6.5	18.5	29.5	13.0
43	Bin	Zhao	66.0	42.5	4.0	35.0	46.7	13.8
44	Zikryya	Rana	66.8	42.5	4.5	31.1	42.8	13.8
45	SPARE		67.5	42.5	5.0	28.0	39.7	13.8
46	SPARE		68.3	42.5	5.5	25.5	37.1	13.8
47	SPARE		69.1	42.5	6.0	23.3	35.0	13.8
48	SPARE		69.9	42.5	6.5	21.5	33.2	13.8