higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

13 November 2017 (X-Paper)
09:00–12:00

CLOSED-BOOK EXAMINATION

Candidates may NOT use any notes, textbooks or references during this examination.

This question paper consists of 7 pages.

SECTION A (COMPULSORY)

QUESTION 1

As an engineer with a legal appointment on a deep level shaft you need to maintain several winders. One of the winders on surface is still a 2 300 HP metvic AC winder. The winder is equipped with a common liquid controller that services both main motors. During the night shift one motor stator developed a fault and needs to be changed before the dayshift.

1.1 Explain in detail how to connect up and recommission the winder using the spare stator. (10)

1.2 Draw the power circuit of the stator reverser configuration. The drawing should include the DC isolation as well as the DC contactors. The DC supply is fed from its own generator set. (5)

1.3 Explain the working principle of the stator reverser with reference to the drawing in QUESTION 1.2. (5)

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QUESTION 2

You are appointed as the services engineer of a tailings facility and need to build a reclaim pump station 5 km away from the Eskom main substation. The substation has 15 MW available to feed the pump station. ALL transformers are configured in parallel.

ALL transformers are ASEA Yd11 ONAF 88 000/66 000 volt.

1. Transformer 1 (No: 1A) = 5 MVA = Impedance (Z) = 3,5%
2. Transformer 2 (No: 2A) = 5 MVA = Impedance (Z) = 3,75%
3. Transformer 3 No: 2B) = 5 MVA = Impedance (Z) = 3,75%

A neutral earthing compensator will be installed with a rating of 300 amp for 10 sec with restricted and sustained earth-fault protection of 300/1 current transformers installed on the mine side.

The pump station requirement is 10 MW.

2.1 Calculate the fault level and fault current at the origin. (4)

2.2 Calculate the possible full-load current at the origin. (2)

2.3 Calculate the possible full-load current needed at the pump station. (2)

2.4 Select the appropriate overhead line conductor that will be necessary from the table below. H-pole structures must be used. (2)

2.5 Calculate the volt drop over the distance. (4)

2.6 What will the actual voltage be at the pump station? (2)

2.7 Calculate the % voltage regulation at the pump station and indicate if this is within limits. (4)

Code Name	Total Area mm²	Total Area inch²	Aluminium Kg/km	Aluminium Lb/M ft	Weight Steel Kg/km	Weight Steel Lb/M ft	Total Kg/km	Total lb/M ft	N	Rated Strength kgf	Rated Strength lbf	Maximum dc Resistance at 20 °C Ohm/km	Maximum dc Resistance at 20 °C Ohm/M ft	Current Rating Temperate Amp	Current Rating Tropical Amp
Mole	12.39	0.0192	29.1	19.6	13.8	9.25	42.9	28.9	4270	435	960	2.63	0.803	92	75
Squirrel	24.43	0.0379	57.4	38.6	27.1	18.2	84.6	56.8	8184	835	1840	1.34	0.407	140	114
Gopher	30.62	0.0475	72.0	48.4	34.0	22.9	106.0	71.2	10052	1025	2260	1.07	0.325	160	130
Weasel	36.88	0.0572	86.8	58.3	41.0	27.6	127.8	85.9	11876	1211	2670	0.885	0.270	179	146
Fox	42.77	0.0663	100.5	67.6	47.5	31.9	148.0	99.5	13789	1406	3100	0.763	0.233	196	159
Ferret	49.48	0.0767	116.3	78.2	55.0	36.9	171.3	115.1	15790	1610	3550	0.660	0.201	213	173
Rabbit	61.70	0.0956	145.1	97.5	68.6	46.1	213.6	143.6	19260	1964	4330	0.529	0.161	243	297
Mink	73.71	0.1142	173.4	116.5	81.9	55.1	255.3	171.6	22107	2254	4970	0.443	0.135	370	218
Skunk	100.50	0.1558	175.9	118.2	289.5	194.6	465.5	312.8	56490	5761	12700	0.422	0.129	269	223
Beaver	87.20	0.1353	205.3	138.0	97.0	65.2	302.3	203.2	25932	2644	5830	0.374	0.114	297	240
Horse	116.20	0.1800	203.1	136.5	334.2	224.6	537.3	361.1	64941	6622	14600	0.365	0.111	289	241
Raccoon	92.40	0.1433	217.3	146.0	102.6	69.0	319.9	215.0	27444	2799	6170	0.353	0.108	307	247
Otter	97.66	0.1517	230.1	154.6	108.7	73.1	338.8	227.7	29045	2962	6530	0.334	0.102	317	255
Cat	111.30	0.1726	261.6	175.8	123.6	83.1	385.2	258.8	33049	3370	7430	0.293	0.0894	341	274
Hare	122.50	0.1899	287.9	193.5	136.0	91.4	423.9	284.9	36340	3705	8170	0.267	0.0812	359	288
Dog	118.5	0.1837	287.9	193.5	106.2	71.4	394.1	264.9	33760	3443	7590	0.269	0.0816	360	312
Hyena	126.2	0.1956	290.2	195.0	159.7	107.3	449.9	302.3	42476	4332	9550	0.264	0.0830	397	316
Leopard	148.1	0.2296	360.1	242.0	133.1	89.46	493.2	331.5	42256	4309	9500	0.214	0.0653	449	358
Coyote	152.2	0.2359	365.7	245.8	155.8	104.7	521.5	350.4	47149	4808	10600	0.214	0.0653	450	358
Cougar	137.5	0.2131	359.0	241.3	56.3	37.8	415.3	279.1	30157	3075	6780	0.219	0.0667	440	351
Tiger	161.7	0.2506	364.3	244.8	239.2	160.8	603.5	405.6	60048	6123	13500	0.214	0.0653	455	361
Wolf	194.9	0.3021	439.2	295.1	288.4	193.8	727.6	489.0	71613	7303	16100	0.178	0.0542	512	406
	167.5	0.2596	437.4	294.0	68.6	46.1	506.0	340.0	35940	3665	8080	0.180	0.0548	498	395
Lynx	226.2	0.3506	508.9	342.0	334.2	224.6	843.1	566.6	82733	8437	18600	0.153	0.0487	562	445
	194.5	0.3016	508.4	341.7	79.7	53.5	588.1	395.2	40521	4132	9110	0.155	0.0472	558	442
Panther	261.5	0.4053	588.8	395.7	395.6	259.8	975.4	655.5	95197	9707	21400	0.132	0.0404	615	486

OVERHEAD LINE DATA

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QUESTION 3

3.1 Distinguish between THREE classes of fires and the type of fire extinguisher that should be used in each case. (3 × 2) (6)

3.2 In an oxygen deficient atmosphere the oxygen content is below a certain percentage.

Name the percentage. (2)

3.3 What causes an oxygen deficient atmosphere in an underground environment? (2)

3.4 What are the sources of carbon dioxide and carbon monoxide in an underground mine? (2)

3.5 Name TWO toxic gases that are common in mining operations. (2)

3.6 Name gases that displace oxygen in confined spaces in a mine or works. (2)

3.7 How can an engineer minimise the risk of asphyxiation of employees on a mine? (4)

[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions in this section.

QUESTION 4

4.1 An underground refrigeration plant used in a mine has two evaporators in parallel located in separate ventilation districts. The refrigerant leaves the compressor at 651,6 kPa and the condensate is not undercooled. After throttling to 182,6 kPa, the refrigerant is passed to the first evaporator and leaves dry and saturated. The refrigeration effect of the first evaporator is 78,4 kJ/s. The remainder of the refrigerant is throttled to 261 kPa and passes to the other evaporator in which the refrigeration effect is 39,2 kJ/s. The refrigerant leaving the second evaporator is dry and saturated. It is further throttled to 182,6 kPa before mixing with the vapour from the first evaporator and then passing the compressor.

Determine the refrigerant circulation (mass flow) in each evaporator and the performance coefficient of the plant.

Given the enthalpy of the refrigerant:

At entrance to the condenser at	651,6 kPa	206 kJ/kg
After condenser at	651,6 kPa	59,7 kJ/kg
After first evaporator at	182,6 kPa	180,97 kJ/kg
After second evaporator at	261 kPa	85,38 kJ/kg

(10)

4.2 Steam for an autoclave is taken from the main at a pressure of 2 MPa and reduced to a pressure of 200 kPa.

Determine the condition of the steam after the reducing valve if the steam in the main is 140 °C overheated.

The specific heat of superheated steam is 2,09. Below is a steam table.

P (kPa)	t_s (°C)	h_f (kJ/kg)	H_{fg} (kJ/kg)	H_g (kJ/kg)
200	120,2	505	2202	2707
2000	212,4	908	1889	2797

(10)
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QUESTION 5

A 4,8 MW, 11 kV separately excited motor, drawing 5,333 MVA at 0.9 power factor leading, drives a 50 000 m^3/h air compressor and is connected in parallel with a process plant drawing 5 MW at 0,8 power factor lagging.

5.1 Name and describe the functions of FOUR other electrical protection devices, besides thermal overload protection, you would expect to find installed to safeguard the compressor motor. (8)

5.2 Calculate the combined power factor when the compressor and processing plant operate simultaneously. (12)
[20]

QUESTION 6

A 3,6 m diameter autogenous mill has a circulating load of 300 t/h of solids of relative density 2,7 in the form of pulp at a relative density of 1,8. The pulp is discharged into a sump where it is diluted to a relative density of 1,25 and then pumped 20 m vertically and 15 m horizontally through a 350 mm diameter pipe to a cyclone.

Given: Friction loss $h = (0{,}001 \times L \times v^2)/d$.

Calculate the following:

6.1 Critical speed of the mill in rev/min (7)

6.2 Water addition in the sump in l/s (6)

6.3 Power of the pump motor to elevate the pulp to the cyclone (assume efficiency of 68%) (7)
[20]

QUESTION 7

7.1 Briefly discuss the advantages of earthing the neutral point of a three-phase power distribution system. (8)

7.2 Distinguish between *neutral earthing* and *equipment earthing*. (4)

7.3 You are the engineer in charge of trackless mobile machinery in a mine and you have to install a test ramp.

Name and describe EIGHT considerations you need to keep in mind to ensure effective braking when designing and constructing this test ramp. (8)
[20]

TOTAL: 100