higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

PLANT ENGINEERING: FACTORIES

(8190316)

3 June 2019 (X-Paper)
09:00–12:00

CLOSED-BOOK EXAMINATION

REQUIREMENTS: Steam tables

Alpha-numerical or programmable calculators may NOT be used.

Non-programmable calculators may be used.

This question paper consists of 7 pages, 1 steam tables page and 1 information sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
PLANT ENGINEERING: FACTORIES
TIME: 3 HOURS
MARKS: 100

NOTE: If you answer more than the required number of questions, only the required number will be marked. All work you do not want to be marked must be clearly crossed out.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions in SECTION A.
2. Answer any TWO of the five questions in SECTION B.
3. Read ALL the questions carefully.
4. Number the answers according to the numbering system used in this question paper.
5. ALL the calculations must be shown.
6. NO marks will be given for calculations in which the steps cannot be clearly followed or for work completed in pencil.
7. Candidates are expected to make reasonable assumptions where necessary and these, together with any formulae used, must be clearly stated.
8. Rule off on completion of each question.
9. This is NOT an OPEN-BOOK EXAMINATION. Candidates are NOT allowed to use any notes, textbooks, references books or cellphones during the examination.
10. Candidates, who were NOT accepted by the commission, will be disqualified.
11. NO candidates may enter the examination room more than half an hour after the start of the examination and NO candidate may leave the examination room before one hour has elapsed.
12. Cellphones are NOT allowed in the examination room.
13. Write neatly and legibly.

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SECTION A

Answer ALL the questions in SECTION A.

QUESTION 1

1.1 State THREE purposes of water treatment in a steam generator. (3)

1.2 Name ONE advantage and ONE disadvantage of using steam for soot blowers in a steam generator. (2)

1.3 State THREE causes of priming in a steam generator. (3)

1.4 Steam is to be condensed by the direct injection of cold water. The steam enters the condenser at a rate of 450 kg/h with a dryness factor of 0,9 and a pressure of 100 kPa. The estimated heat loss from the condenser to the surroundings is 800 kJ/h. The specific heat capacity of water is 4,186 kJ/kg.K.

If the cold water enters the condenser at a temperature of 15 °C and the mixture of condensate and cooling water is to leave the condenser at 95 °C, determine the rate of flow of the required cooling water. (12)

[20]

QUESTION 2

2.1 A DC series motor runs at 600 r/min when taking 110 A from a 240 V supply. The resistance of the armature circuit is 0,12 Ω and that of the series winding is 0,03 Ω.

Calculate the speed when the current has fallen to 50 A, assuming the useful flux per pole for 110 A to be 0,024 Wb and that for 50 A to be 0,0155 Wb. (10)

2.2 2.2.1 State TWO applications where DC motors are used.

2.2.2 Give a reason for each use you mentioned in QUESTION 2.2.1. (2 × 1) (2)

2.3 Name SIX losses in a three-phase induction motor. (6)

2.4 Name TWO different methods of cooling power transformers. (2)

[20]

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QUESTION 3

3.1 SANS/ISO 45001: 2018: Occupational Health and Safety Management Systems – Requirements with guidelines for use (previously known as OHSAS 18001), is a health and safety management system.

3.1.1 Name FIVE commitments that must be included in the Health and Safety policy. (5)

3.1.2 The hierarchy of control is intended to provide a systematic approach to enhance occupational health and safety, eliminate hazards and reduce or control OH&S risks. Each control is considered less effective than the one before it. It is usual to combine several controls in order to succeed in reducing OH&S risks to a level that is as low as reasonably practicable.

Give FIVE examples to illustrate measures that can be implemented at each level. (5)

3.2 An electric motor for a valve on a flammable gas pipe line has to be replaced in a Zone 0 hazardous location.

Draw up a procedure before such a motor may be replaced. (10)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO of the five questions in SECTION B.

QUESTION 4

4.1 A factory takes 900 kVA at a lagging power factor of 0,6. A synchronous motor is to be installed to raise the power factor to 0,9 lagging when the motor is taking 300 kW.

Calculate the corresponding kilovolt-amperes (kVA) taken by the synchronous motor and the power factor at which the motor will be operating. (10)

4.2 An employee was electrocuted by a newly installed three-phase industrial dough mixer.

Name THREE tests that should be carried out on the installation to find the cause of the incident and give a reason for performing each test. (6)

4.3 State FOUR requirements for the installation of an isolator in the electrical installation for the mixer mentioned in QUESTION 4.2. (4)
[20]

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QUESTION 5

5.1 Use the information given below to calculate the following:

5.1.1 The power required by a motor to drive a coal conveyor belt

5.1.2 The maximum and minimum tensions in the conveyor belt

INFORMATION

Centre distance between the tail and head pulleys	250 m
Vertical lift	20 m
Capacity of conveyor belt	300 t/h
Belt speed	1,2 m/s
Belt width	600 mm
Drive pulley angle of wrap, single-lagged	210°
Coefficient of friction	0,3
Friction factor: empty belt	0,035
Friction factor: loaded belt	0,04
Mass of empty belt moving parts	36 kg/m
Take-up type	gravity
Drive efficiency	0,75

(12)

5.2 The pipes used for transporting fluidised coal from the crushing plant to the steam generator needs to be lined with ceramic.

Name FOUR advantages and FOUR limitations for using ceramic. (4 × 2) (8)

[20]

QUESTION 6

6.1 The primary and secondary windings of a 500 kVA transformer have resistances of 0,42 Ω and 0,0011 Ω respectively. The primary and secondary voltages are 6 600 V and 400 V respectively and the iron loss is 2,9 kW. Assume that the power factor of the load is 0,8.

Calculate the efficiency on:

6.1.1 Full load (6)

6.1.2 Half load (4)

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6.2 A 3-phase motor rated at 75 kW, runs continuously and receives power from a 380 V switchboard via a contactor and back-up fuses.

Motor: Full load efficiency = 95% and full load power factor = 0,8
The supply cable is on an open rack and is 150 m long.

Determine the correct size of the cable from the following data:

CABLE

Size (mm^2)	Current rating (A)	Resistance @ 70 °C (Ω/km)
35	125	0,6162
50	155	0,4295
70	190	0,3063
95	230	0,2261

(7)

6.3 Explain THREE methods of how to locate a fault in a buried 3-core PVC sheathed PILC SWA cable. (3)
[20]

QUESTION 7

7.1 Sand with a density of 2 600 kg/m^3 when dry is pumped as slurry with a density of 1 400 kg/m^3 through a pipe with a friction coefficient of 0,007 from a sandy area. The length of the pipe is 1 km and it discharges 250 m above the pump. Assume a rate of flow of 2,5 m/s to prevent settling of solids in the pipe. The transfer rate is 60 tons/hour of dry sand.

Determine the following:

7.1.1 How much water is used per hour

7.1.2 A suitable pipe size

7.1.3 How much electrical power is needed for the pumping operation

(3 × 4) (12)

7.2 Name FIVE benefits of adding water filter head and filter to a cooling system. (5)

7.3 Name THREE possible signs of debris or contaminant in the coolant coupled with poor to no filtration. (3)
[20]

QUESTION 8

8.1 Name FIVE different types of electrical cables and state where each type is used. Also make a cross-sectional sketch of each type. (5 × 2) (10)

8.2 An electrical cable with a mass of 2,55 kg/m needs to be installed across a road. The poles have the same length, but the difference in the horizontal level on the sides of the road is 2 metres. The lowest point of the cable must not be lower than 5 metres from the higher connection point. This ensures the minimum clearance between the cable and the road. The maximum tension in the cable must not exceed 2 kN and g = 9,81 m/s^2.

Calculate:

8.2.1 The tension in the cable at the lower fixing point so that an appropriate attachment can be designed

8.2.2 The length of the cable

8.2.3 The horizontal distance between the two poles

(10)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

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STEAM TABLES

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg. K	kJ/kg. K
1,0	7,0	129,20	29	2 485	2 514	0,106	8,977
1,5	13,0	87,98	55	2 471	2 526	0,196	8,829
2,0	17,5	67,01	74	2 460	2 534	0,261	8,725
2,5	21,1	54,26	89	2 452	2 541	0,312	8,644
3,0	24,1	45,67	101	2 445	2 546	0,354	8,579
3,5	26,7	39,48	112	2 439	2 551	0,391	8,523
4,0	29,0	34,80	121	2 433	2 554	0,423	8,476
4,5	31,0	31,14	130	2 428	2 558	0,451	8,434
5,0	32,9	28,19	138	2 424	2 562	0,476	8,396
5,5	34,6	25,77	145	2 420	2 565	0,500	8,362
6,0	36,2	23,74	152	2 416	2 568	0,521	8,331
6,5	37,7	22,02	158	2 413	2 571	0,541	8,303
7,0	39,0	20,53	163	2 410	2 573	0,559	8,277
7,5	40,3	19,24	169	2 406	2 575	0,576	8,252
8,0	41,6	18,10	174	2 403	2 577	0,593	8,230
8,5	42,7	17,10	179	2 401	2 580	0,608	8,208
9,0	43,8	16,20	183	2 398	2 581	0,622	8,188
9,5	44,8	15,40	188	2 395	2 583	0,636	8,169
10	45,8	14,67	192	2 393	2 585	0,649	8,151
11	47,7	13,42	200	2 388	2 588	0,674	8,118
12	49,5	12,36	207	2 384	2 591	0,696	8,087
13	51,1	11,47	214	2 380	2 594	0,717	8,059
14	52,6	10,69	220	2 377	2 597	0,737	8,033
15	54,0	10,02	226	2 373	2 599	0,755	8,009
16	55,3	9,433	232	2 370	2 602	0,772	7,987
17	56,6	8,911	237	2 367	2 604	0,788	7,966
18	57,8	8,445	242	2 364	2 606	0,804	7,946
19	59,0	8,027	247	2 361	2 608	0,818	7,927
20	60,1	7,650	252	2 358	2 610	0,832	7,909
21	61,1	7,307	256	2 356	2 612	0,845	7,893
22	62,2	6,995	260	2 353	2 613	0,858	7,876
23	63,1	6,709	264	2 351	2 615	0,870	7,861
24	64,1	6,447	268	2 349	2 617	0,882	7,846
25	65,0	6,204	272	2 346	2 618	0,893	7,832
26	65,9	5,980	276	2 344	2 620	0,904	7,819
27	66,7	5,772	279	2 342	2 621	0,915	7,806
28	67,6	5,579	283	2 340	2 623	0,925	7,793
29	68,3	5,398	286	2 338	2 624	0,935	7,781
30	69,1	5,229	289	2 336	2 625	0,944	7,770
32	70,6	4,922	296	2 332	2 628	0,962	7,747
34	72,0	4,650	302	2 329	2 631	0,980	7,727
36	73,4	4,408	307	2 326	2 633	0,996	7,707
38	74,7	4,190	313	2 322	2 635	1,011	7,688
40	75,9	3,993	318	2 319	2 637	1,026	7,671
45	78,7	3,576	330	2 312	2 642	1,060	7,631
50	81,4	3,240	341	2 305	2 646	1,091	7,595
55	83,7	2,964	351	2 299	2 650	1,119	7,562
60	86,0	2,732	360	2 294	2 654	1,145	7,533
65	88,0	2,535	369	2 288	2 657	1,170	7,506
70	90,0	2,365	377	2 283	2 660	1,192	7,480

p	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg. K	kJ/kg. K
75	91,8	2,217	385	2 279	2 664	1,213	7,457
80	93,5	2,087	392	2 274	2 666	1,233	7,435
85	95,2	1,972	399	2 270	2 669	1,252	7,415
90	96,7	1,869	405	2 266	2 671	1,270	7,395
95	98,2	1,777	412	2 262	2 674	1,287	7,377
100	99,6	1,694	418	2 258	2 676	1,303	7,360
110	102,3	1,549	429	2 251	2 680	1,333	7,328
120	104,8	1,428	439	2 244	2 683	1,361	7,300
130	107,1	1,325	449	2 238	2 687	1,387	7,272
140	109,3	1,236	458	2 232	2 690	1,411	7,247
150	111,4	1,159	467	2 226	2 693	1,434	7,223
160	113,3	1,091	475	2 221	2 696	1,455	7,202
170	115,2	1,031	483	2 216	2 699	1,475	7,181
180	116,9	0,977 2	491	2 211	2 702	1,494	7,162
190	118,6	0,929 0	498	2 206	2 704	1,513	7,144
200	120,2	0,885 4	505	2 202	2 707	1,530	7,127
210	121,8	0,845 9	511	2 197	2 708	1,547	7,111
220	123,3	0,809 8	518	2 193	2 711	1,563	7,095
230	124,7	0,776 8	524	2 189	2 713	1,578	7,080
240	126,1	0,746 5	530	2 185	2 715	1,593	7,066
250	127,4	0,718 4	535	2 181	2 716	1,607	7,052
260	128,7	0,692 5	541	2 177	2 718	1,621	7,039
270	130,0	0,668 4	546	2 174	2 720	1,634	7,026
280	131,2	0,646 0	551	2 170	2 721	1,647	7,014
290	132,4	0,625 1	557	2 167	2 724	1,660	7,002
300	133,5	0,605 6	561	2 163	2 724	1,672	6,991
310	134,7	0,587 2	566	2 160	2 726	1,683	6,980
320	135,8	0,570 0	571	2 157	2 728	1,695	6,969
330	136,8	0,553 8	576	2 154	2 730	1,706	6,959
340	137,9	0,538 5	580	2 150	2 730	1,717	6,949
350	138,9	0,524 0	584	2 147	2 731	1,727	6,939
360	139,9	0,510 3	589	2 144	2 733	1,738	6,930
370	140,8	0,497 4	593	2 141	2 734	1,748	6,921
380	141,8	0,485 1	597	2 139	2 736	1,757	6,912
390	142,7	0,473 4	601	2 136	2 737	1,767	6,903
400	143,6	0,462 2	605	2 133	2 738	1,776	6,894
410	144,5	0,451 6	609	2 130	2 739	1,786	6,886
420	145,4	0,441 5	612	2 128	2 740	1,795	6,878
430	146,3	0,431 8	616	2 125	2 741	1,803	6,870
440	147,1	0,422 6	620	2 122	2 742	1,812	6,862
450	147,9	0,413 8	624	2 120	2 744	1,820	6,855
460	148,7	0,405 3	627	2 117	2 744	1,829	6,847
470	149,5	0,397 2	630	2 115	2 745	1,837	6,840
480	150,3	0,389 4	634	2 112	2 746	1,845	6,833
490	151,1	0,381 9	637	2 110	2 747	1,853	6,826
500	151,8	0,374 7	640	2 107	2 747	1,860	6,819
520	153,3	0,361 1	647	2 103	2 750	1,875	6,806
540	154,8	0,348 5	653	2 098	2 751	1,890	6,793
560	156,2	0,336 7	659	2 094	2 753	1,904	6,781
580	157,5	0,325 7	665	2 089	2 754	1,918	6,769

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PLANT ENGINEERING: FACTORIES

INFORMATION SHEET

$$P = \sqrt{3}\, V\ I\ Cos\ \theta$$

$$Q = mC\Delta t$$

$$P = (T_1 - T_2)\, v$$

$$P = mglSin\ \theta$$

$$P = \mu mgL$$

$$M = fz$$

$$hf = \frac{4\, fLv^2}{2gd}$$

$$h = \frac{k\ v^2}{2g}$$

$$pv = mRT$$

$$\frac{M}{I} = \frac{\sigma}{Y} + \frac{E}{R}$$

$$M = \frac{WL^2}{2}$$

$$M = WL$$

$$M = \sigma Z$$

$$T = \sigma_s A_s$$

$$I = \frac{\pi\left(D^4 - d^4\right)}{64}$$

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$$

$$Z = \frac{I}{Y}$$

$$I_{XX} = \frac{\pi(D^4 - d^4)}{64}$$

$$h = \frac{4Sin\ \phi/2}{\phi + Sin\phi} \times R$$

$$T/h = CW^2\rho v$$

$$Q = \frac{UA(\phi_1 - \phi_2)}{Ln(\phi_1/\phi_2)}$$

$$W = \frac{n}{n-1}\cdot P_1V_1\{P_2/P_1)\exp[(n-1)/n] - 1\}$$

$$V_{sphere} = \frac{\pi D^3}{6}$$

$$\Delta V_{sphere} = \frac{\pi PD^4}{8tE} \times (1 - v)$$

$$z = \frac{\pi(D^4 - d^4)}{32D}$$

$$t_m = \frac{\Delta t_{in} - \Delta t_{out}}{\ln \frac{\Delta t_{in}}{\Delta t_{out}}}$$

$$t = \frac{2A}{C_d\, a\, \sqrt{2g}}\left(H_1^{0,5} - H_2^{0,5}\right)$$

$$C = \frac{\sigma_c}{2}\, bn$$

$$\frac{n}{d-n} = m\,\frac{\sigma_c}{\sigma_s}$$

$$\Delta P = \frac{32\ \mu\, L\, v}{D^2}$$

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