EXAMINATION FOR THE ENGINEER'S CERTIFICATE OF COMPETENCY

PLANT ENGINEERING (MINING AND FACTORIES) (1628)

8 June (X-Paper)
09:00 - 13:00

REQUIREMENTS: Graph paper
Pocket calculators may be used.
Alpha-numerical or programmable calculators may NOT be used.
Afrikaans op keersy

Total marks: 100
To pass: 50

INSTRUCTIONS

All calculations are to be shown.
No credit will be given for calculations in which the steps cannot be clearly followed.
Candidates are expected to make reasonable assumptions where necessary and these, together with any formula used, must be clearly stated.
Candidates are not allowed to use any notes, text or reference books during the examination.
Answer QUESTION 1 and QUESTION 2 and any THREE other questions.

QUESTION 1 (COMPULSORY)

(a) State FOUR means of identifying when a fan is running in the stalled condition, and list the immediate action to be taken when a fan is found to be operating in the stall zone. (7)
(b) A fan, having the characteristics tabled below, is driven by an electric motor with a maximum output of 37 kW through a vee grooved belt drive which has an efficiency of 92%.

The characteristics shown are for an air density of 1 kg/m³.

The fan is to be relocated at a lower altitude where the air density is 1.25 kg/m³ and the resistance is 1.62 kPa.

Using the graph paper supplied and scales of 10 mm = 1 m/s; 100 Pa; 10 kW, redraw the characteristics for the new height and conditions and determine whether the existing motor is still suitable for driving the fan at its new site.

<table>
<thead>
<tr>
<th>Quantity (m³/s)</th>
<th>10</th>
<th>12.5</th>
<th>15</th>
<th>17.5</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (kPa)</td>
<td>1.57</td>
<td>1.62</td>
<td>1.43</td>
<td>1.07</td>
<td>0.6</td>
</tr>
<tr>
<td>Power (kW)</td>
<td>22.3</td>
<td>25.5</td>
<td>27.2</td>
<td>26.4</td>
<td>21.7</td>
</tr>
</tbody>
</table>

QUESTION 2 (COMPULSORY)

A 4.8 MW, 11 kV, separately excited motor, drawing 5,333 MVA at 0.9 power factor leading drives a 50 000 m³/h air compressor and is connected in parallel with a process plant drawing 5 MW at 0.8 power factor lagging.

(a) Besides thermal overload protection, describe the function of FOUR other electrical protection devices you would expect to find installed to safeguard the compressor motor.

(b) Calculate the combined power factor when the compressor and plant operate simultaneously.

Answer any THREE of the following questions.

QUESTION 3

(a) Specify the quality control a supplier must implement during the manufacture of passenger lift rope connections and supporting equipment.

(b) The effective diameter of a goods hoist drum is 900 mm, its radius of gyration is 350 mm and its mass is 100 kg. A load of 320 kg is to be raised 36 m by a rope having a mass of 1 kg/m.

If the acceleration is 1.8 m/s² and the full speed of the hoist is 6 m/s, determine the power expended just at the end of the acceleration period.
QUESTION 4

(a) A 4.27 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 the friction loss \( h = \frac{0.001 x L x v^2}{d} \)

Calculate the:

(a) critical speed of the mill in \( r/min \)  
(b) water addition in the sump in \( l/s \)  
(c) power of the pump motor to elevate the pulp to the cyclone  

[20]

QUESTION 5

(a) Sketch a washbox and scraper arrangement to eliminate fines from the head pulley of a 900 mm wide conveyor belt.

(b) The pitch circle diameter of a used bucket elevator head sprocket is 500 mm and the distance from the centre of gravity of the load in the bucket is 100 mm. The capacity of the buckets is 0.01 m³ and they are spaced 600 mm apart.

If the elevator is required to raise sugar with a bulk density of 800 kg/m³, 20 m vertically and discharge the contents of the buckets 45° past top dead centre, calculate the:

(i) speed of the chain in \( m/s \)  
(ii) capacity of the bucket elevator in \( t/h \)  
(iii) power of the motor  

[20]

QUESTION 6

(a) Explain why excess water is detrimental to a mixture of concrete.  

(4)
(b) Verify that the retaining wall of bulk density 2.2 t/m$^3$ depicted in the sketch is capable of retaining sand of bulk density 1.5 t/m$^3$.

Rankine's formula is $p = \frac{q(1 - \sin 30^\circ)}{1 + \sin 30^\circ}$ \hspace{1cm} (8)

(c) Calculate the maximum foundation pressure in kPa.

SECTION OF RETAINING WALL

QUESTION 7

A 525 V, 3-phase, 45 kW, 1440 r/min motor is controlled with a star-delta starter. The power factor and efficiency are 0.85 and 0.92 respectively.
(a) If the THREE windings are marked U₁-U₂, V₁-V₂, W₁-W₂, respectively, sketch the power and control circuits of the star-delta starter showing how the following components are connected:

main isolator
line contactor
motor windings
star contactor
delta contactor

(b) When the motor is started in delta with a direct on line starter, the motor draws 6 times full load current and produces 2,2 times full load torque. What are the equivalent values when started with the star-delta starter?

(c) When the motor runs at full load in delta, calculate the phase and line currents.

QUESTION 8

(a) A worker was struck and fatally injured when a rope broke causing a 1 t block-and-hook to drop from a drill rig. Investigation following the accident revealed that several persons witnessed the operator deliberately misusing the overload safety protection as a brake when raising the drill rods, rather than manually activating the regular hoist brake.

Discuss techniques to motivate people to recall and report incidents like the above when they occur in order to save lives or avert other serious loss.

(b) The responsibility of hazard control on a plant is too large for an individual or a small group to carry by themselves.

Describe the contribution of the engineering department towards hazard control.

TOTAL: 100
(a) Indien die DRIE wikkelings respektiewelik $U_1 - U_2$, $V_1 - V_2$ en $W_1 - W_2$ gemerk is,
skets die beheer- en kragstroombane van die ster-
delta-aansitter en toon hoe die volgende kompo-
nente gekoppel is:

hoofisolator
lynkontaktor
motorwindings
sterkontaktor
deltakontaktors

(b) Wanneer die motor in delta direk aanlyn aangeskakel
word, trek die motor 6 keer die vollastroom en die
wiringstog is 2,2 keer die vollaswiringstog.
Wat sal die ekwivalente waardes wees wanneer die
motor met 'n ster-delta-aansitter aangeskakel word?

(c) Bereken die fase- en lynstroom van die motor in
delta wanneer die motor teen vollas loop.

VRAAG 8

(a) 'n Werker is getref en noodlottig beseer toe hy deur
'n 1 ton-katrol-en-haak getref is nadat die tou waaraan
die katrol gehang het, gebreek het. Die daarop-
volgende ondersoek na die ongeluk het aan die lig
gebring dat verskeie persone gesien het dat die
operator die oorlast veiligheidbeskerming doelbewus
misbruik het as 'n rem, wanneer hy boorstawe gehys
het, in plaas van sy gewone hystoestelrem met die
hand aan te wend.

Bespreek die tegnieke om persone te motiveer om
soortgelyke ongelukke aan te meld wanneer dit ge-
beur en om lewensverlies en ander ernstige verliese
te voorkom.

(b) Die verantwoordelikheid om gevare by 'n aanleg te
beheer is te veel vir een persoon of selfs vir 'n
klein groep.

Beskryf die bydrae wat 'n ingenieursdepartement
kan lewer tot gevaarbeheer.

TOTAAL: 100