UNIVERSITY
OF
JOHANNESBURG

PROGRAM	:	BACCALAUREUS TECHNOLOGIAE *EXTARCTION METALLURGY*
SUBJECT	:	**PROCESS CONTROL IV**
CODE	:	**MPE 32-1**
DATE	:	SUMMER SSA EXAMINATION 2015 10 DECEMBER 2015
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40 : 60
TOTAL MARKS	:	85

EXAMINER	:	MR MK KALENGA	5142
MODERATOR	:	LM OMARI	
NUMBER OF PAGES	:	3 PAGES AND 2 ANNEXURES	

INSTRUCTIONS	:	QUESTION PAPERS MUST BE HANDED IN.
REQUIREMENTS	:	CALCULATORS ARE REQUIRED

INSTRUCTIONS TO CANDIDATES:

PLEASE ANSWER ALL THE QUESTIONS.

QUESTION 1

During electrowining of Cobalt, it is noticed that zinc is polluting the Cobalt deposited at the cathode. It is suggested that investigations be conducted in order to propose solu tions to be implemented therefore improve the quality of the cobalt. Amongst parame ters to investigate are temperature of the solution, flow rate and concentration of zinc in the solution. Discuss the possibility of disturbances that you may encounter when establishing the state equations that should govern best the electrowining process.

[15]

QUESTION 2

During the production of copper matte, a slag is produced and is not recycled, granulated in a water bath and is stockpiled. During the granulation, some water evaporates and another amount remains liquid. The initial temperature of water is assumed to be the room temperature (say 25 C). The vapor released is collected in a tube to heap up the feed of the furnace to decrease the heat required needed in the furnace. You are overseeing the granulation section. It is of no doubt that the amount of slag produced depends on the quality of the feed. Also, the temperature to which the feed is brought to depends on the amount of water converted into vapor. Your boss requests the follo wing:

2.1 Establish a mathematical equation that will help him to have a hint in predicting the size of reserve of water depending on the quality of the feed. Assume that the reservoir is cylindrical (diameter is d and height of water h in the reservoir) (20)

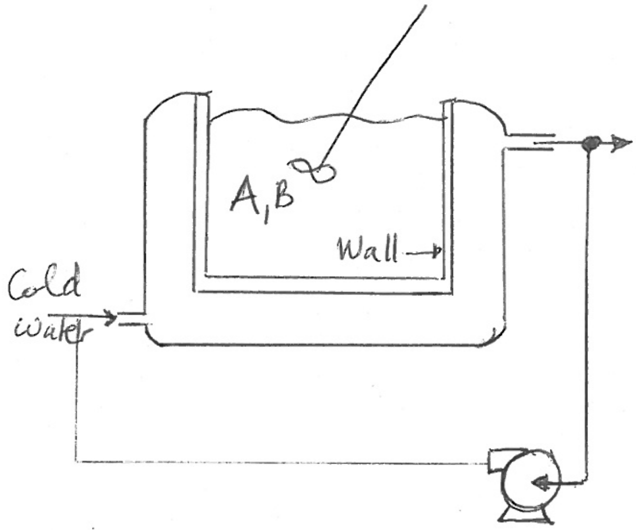
2.2 Conduct a qualitative analysis of the mathematical model. Does your model suffer from insufficient variables? Discuss (10)

[30]

QUESTION 3

Develop a state model for the cooling system shown in the Figure below. The content of the tank is a mixture of components A (slag) and B (metal) and is being cooled by constant flow of cold water circulating through the jacket.

Assume that the two phases are mixed and are not separated. Assume any metal and any slag.



[20]

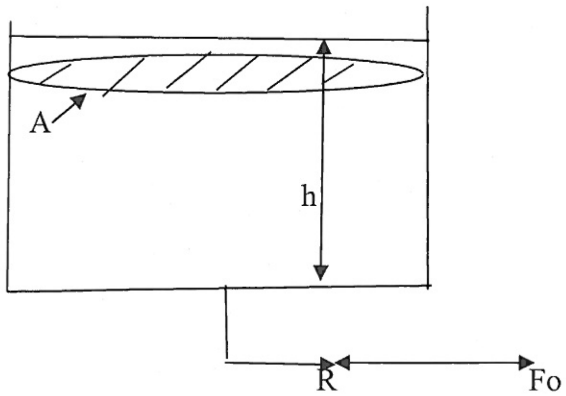
QUESTION 4

Consider the tank in The Figure below. The volumetric (volume/time) flow in is *Fi* and the outlet volumetric flow rate is *Fo*. In the outlet stream there is a resistance to flow, such as a pipe, valve, or weir. Assume that the effluent flow *Fo* is related linearly to the hydrostatic pressure of the liquid level h, through the resistance *R*:

Fo = h/ R= driving force for flow/ resistance to flow

4.1 Establish the transfer function of the process

4.2 Investigate whether the process is stable/ or not



[20]

TOTAL: 85

Laplace Transform Pairs

$f(t)$	$\bar{f}(s)$
$\sin(at)$	$\frac{a}{s^2+a^2}$
$\cos(at)$	$\frac{s}{s^2+a^2}$
$\frac{1-\cos(at)}{a^2}$	$\frac{1}{s(s^2+a^2)}$
$\frac{at-\sin(at)}{a^3}$	$\frac{1}{s^2(s^2+a^2)}$
$\frac{\sin(at)-at\cos(at)}{2a^3}$	$\frac{1}{(s^2+a^2)^2}$
$\frac{t\sin(at)}{2a}$	$\frac{s}{(s^2+a^2)^2}$
$\frac{\sin(at)+at\cos(at)}{2a}$	$\frac{s^2}{(s^2+a^2)^2}$
$\frac{\cos(at)-\cos(bt)}{b^2-a^2}$	$\frac{s}{(s^2+a^2)(s^2+b^2)}$
$\frac{1-\cos(at)-\frac{1}{2}at\sin(at)}{a^4}$	$\frac{1}{s(s^2+a^2)^2}$
$\frac{\frac{1}{a}\sin(at)-\frac{1}{b}\sin(bt)}{b^2-a^2}$	$\frac{1}{(s^2+a^2)(s^2+b^2)}$
$\sin(a+bt)$	$\frac{s\sin(a)+b\cos(a)}{s^2+b^2}$
$\cos(a+bt)$	$\frac{s\cos(a)-b\sin(a)}{s^2+b^2}$
$\sin(at)\sin(bt)$	$\frac{2abs}{[s^2+(a-b)^2][s^2+(a+b)^2]}$
$\cos(at)\cos(bt)$	$\frac{s(s^2+a^2+b^2)}{[s^2+(a-b)^2][s^2+(a+b)^2]}$
$\sin(at)\cos(bt)$	$\frac{a(s^2+a^2-b^2)}{[s^2+(a-b)^2][s^2+(a+b)^2]}$

Laplace Transform Pairs

$f(t)$	$\bar{f}(s)$
1	$\frac{1}{s}$
$t^n,\ n=0,1,2,\ldots$	$\frac{n!}{s^{n+1}}$
$t^\nu,\ \nu>1$	$\frac{\Gamma(\nu+1)}{s^{\nu+1}}$
$t^{n-1/2}$	$\left(\frac{\sqrt{\pi}}{2}\right)\left(\frac{3}{2}\right)\left(\frac{5}{2}\right)\cdots\left(\frac{n-1}{2}\right)\frac{1}{s^{n+1/2}}$
e^{-at}	$\frac{1}{s+a}$
te^{-at}	$\frac{1}{(s+a)^2}$
$\frac{e^{-at}-e^{-bt}}{b-a}$	$\frac{1}{(s+a)(s+b)}$
$\frac{ae^{-at}-be^{-bt}}{b-a}$	$\frac{s}{(s+a)(s+b)}$
$\frac{e^{at}-1}{a}$	$\frac{1}{s(s-a)}$
$\frac{e^{at}-at-1}{a^2}$	$\frac{1}{s^2(s-a)}$
$\frac{e^{at}-\frac{1}{2}a^2t^2-at-1}{a^3}$	$\frac{1}{s^3(s-a)}$
$(1+at)e^{at}$	$\frac{s}{(s-a)^2}$
$\frac{1+(at-1)e^{at}}{a^2}$	$\frac{1}{s(s-a)^2}$
$\frac{2+at+(at-2)e^{at}}{a^3}$	$\frac{1}{s^2(s-a)^2}$
$t^n e^{at},\ n=0,1,2,\ldots$	$\frac{n!}{(s-a)^{n+1}}$
$\frac{\frac{1}{a}e^{at}-\frac{1}{b}e^{bt}+\frac{1}{b}-\frac{1}{a}}{a-b}$	$\frac{1}{s(s-a)(s-b)}$