UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. *M.Eng.*

Biochemical Eng E125: Computer Aided Bioprocess Engineering

COURSE CODE	:	**BENGE125**
UNIT VALUE	:	**0.50**
DATE	:	**12-MAY-05**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

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Answer ***THREE QUESTIONS including Question 1. Only the first three answers will be marked. The marks for each question distributed as shown*** [ ]

1. This question is compulsory.

(a) Show why standard Newton-Raphson algorithms fail to solve the following problem, if the initial point used to start the algorithm is $x_1=0$, and $x_2=0$

$$2 x_1 x_2 + 3 x_2 - 1 = 0$$

$$x_1^2 x_2 - 1 = 0$$ [5]

(b) The program below has been developed to solve the following equation using the Newton-Raphson method:

$x^3 + 2x - 5=0$.

There are at least 5 errors. Identify the errors and correct them.

```
% non-linear equation solving using Newton method

%Choose x0, e, N, k

e=0.0001;
N=1000;
k=0
f=x^3+2x-5;

% Newton iteration

while f <0.0001
if k ≤ N;
df=3*x^2+2;
x1=x-f/df;
x=x1;
f=x^3+2*x-5;

end
```

[5]

(c) Explain briefly what sensitivity analysis can achieve in Linear programming. [5]

(d) Discuss briefly why it is important to choose suitable step sizes in numerical methods for solving ordinary differential equations. [5]

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(e) A labour demand chart for a particular production process by SuperPro Design is shown in Figure 1. Currently the company has 6 staff for this process. Assess if there is any labour bottleneck. If so, give 2 suggestions for debottlenecking. [5]

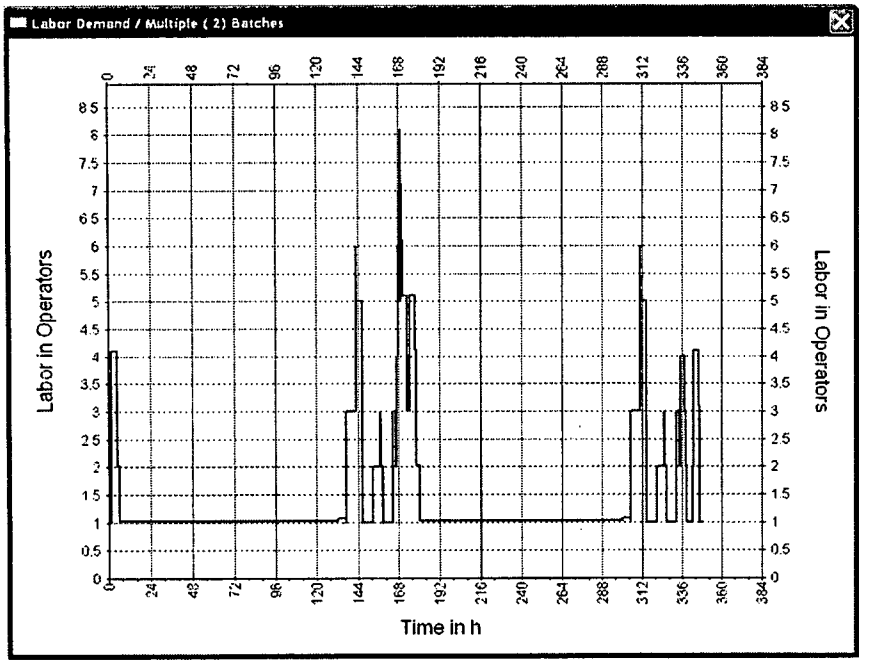
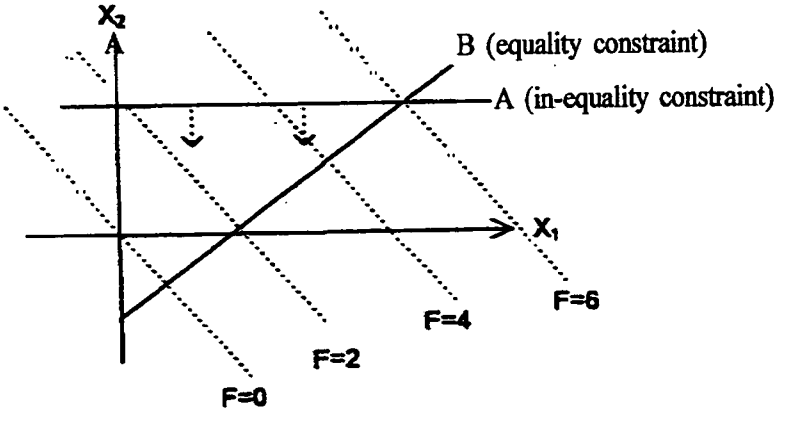


Figure 1 Labour demand chart

2.

(a) Explain briefly in words the difference between a feasible solution, a feasible region and an optimal solution for a general LP problem. Illustrate the feasible region and suggest an optimal solution for the maximisation problem given in the figure below. Assume the following non-negativity constraints: $x_1, x_2, \geq 0$ [8]



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(b) A biotech company manufactures and sells 3 products. The fermentation media for each product are prepared using three common ingredients: A, B and C. The amount of these ingredients required per batch and the profit per batch for each product are shown in the table below.

	Product 1	Product 2	Product 3
A (kg)	2	2	1
B (kg)	2	3	3
C (kg)	2	4	1
Profit (£)	400	500	350

Currently there are 35 kg of A, 50kg of B and 40kg of C available.

The company wishes to determine how many batches of each product it should make so to maximise its profit and satisfy the constraints. Formulate a linear programming problem for the company. [12]

3.

(a) Write a MATLAB programme for solving the following differential equation using the Forward Euler's method for $0 \leq t \leq 5$.

$$\frac{dy(t)}{dt} = \sqrt{y(t)}$$

$$y(0) = 1$$

Your programme should include statements which will generate a graph of y(t) and appropriate comments, where necessary, for easy understanding of your programme [10]

(b) One 2nd order Runge-Kutta method is given by

$$y_{n+1} = y_n + \frac{2}{3}k_1 + \frac{1}{3}k_2$$

$$k_1 = h\, f(y_n, t_n)$$

$$k_2 = h\, f(y_n + \frac{3}{2}k_1, t_n + \frac{3}{2}t_n)$$

Apply this method to the initial value problem in a) using a step size of 1 to achieve the value of y (t) after one iteration. [10]

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4.

(a) Define the equipment capacity utilisation, equipment uptime and combined utilisation of a fermenter. [8]

(b) A biotech company produces a therapeutic monoclonal antibody of 70kg each year. Due to increased market demand, the company is interested in increasing throughput. The current process flowsheet, equipment use chart, capacity, time and combined use charts are shown in the following figures. You are asked to propose two strategies to increase the throughput and then discuss their process implication and financial implication. [12]

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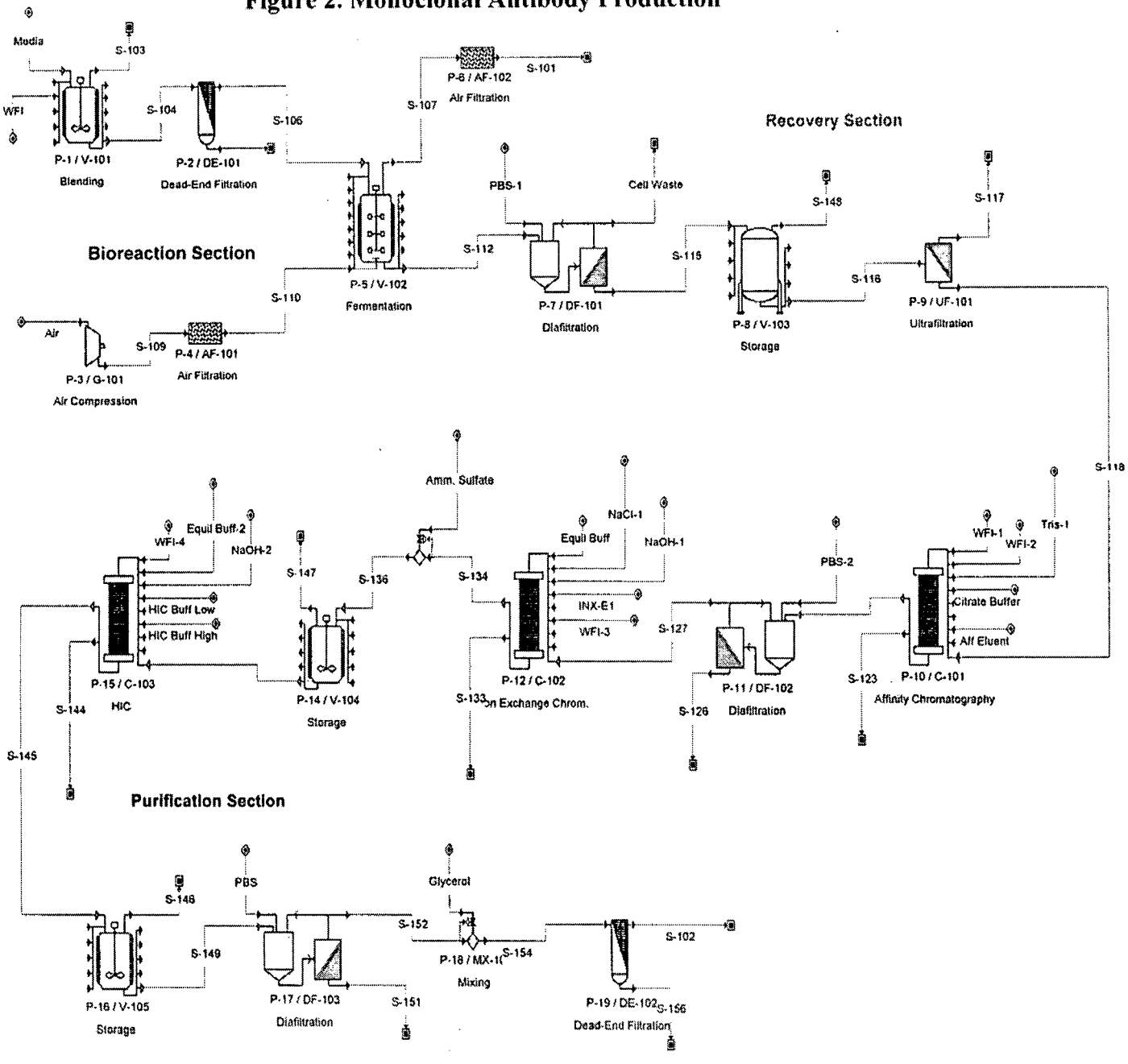
Figure 2. Monoclonal Antibody Production



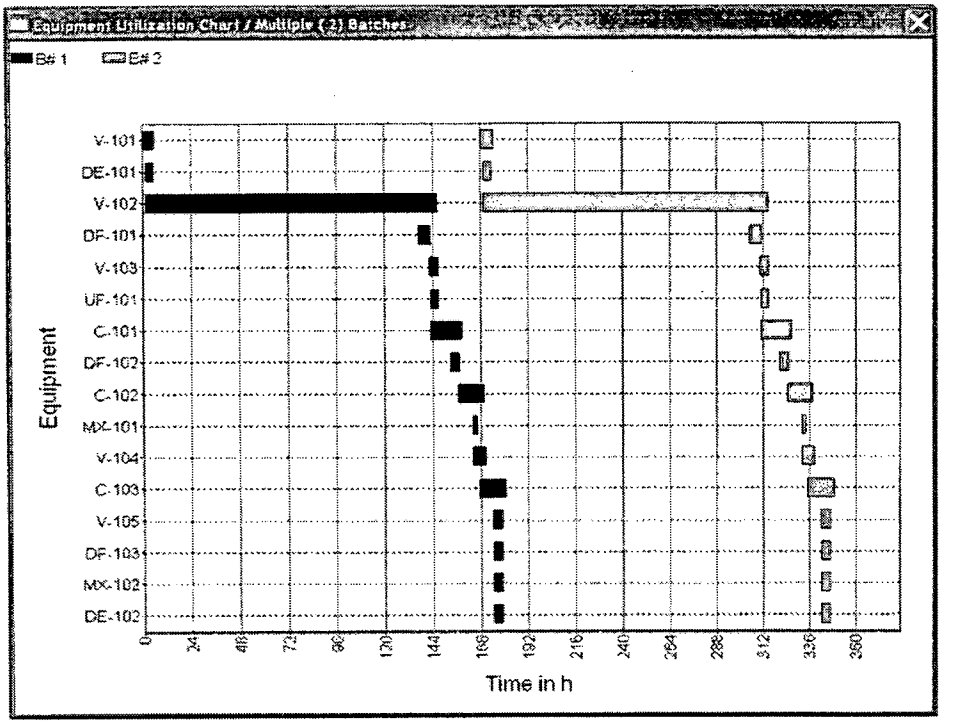


Figure 3 Equipment use chart

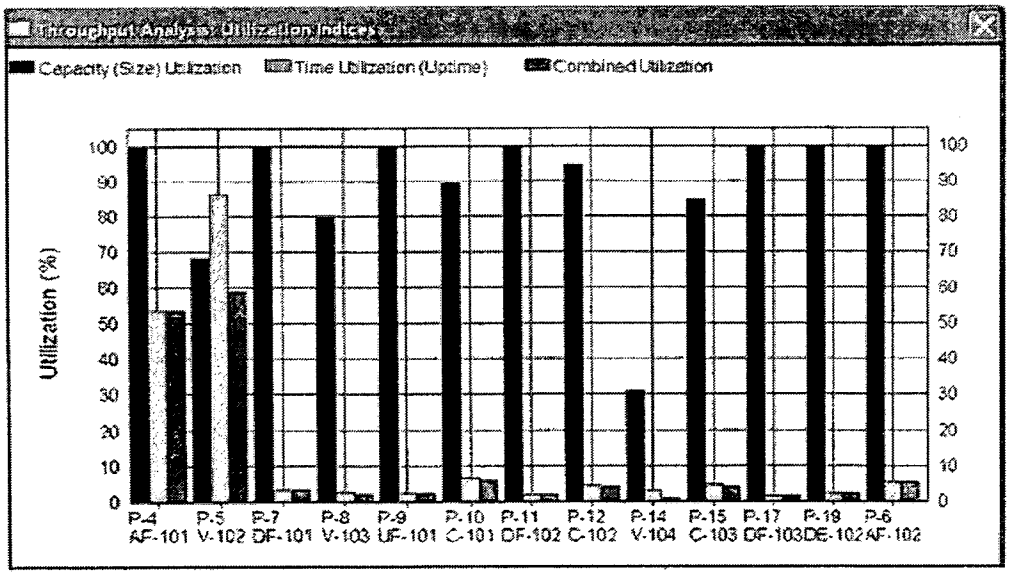


Figure 4. Capacity, time and combined use chart

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