UNIVERSITY OF BOLTON

SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING

BSc(HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2008/2009

MATHEMATICS B

MODULE NO: BLT1010

Date: Wednesday 27 May 2009 **Time: 10.00 am – 12.00 noon**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions.

Answer THREE questions.

This examination paper carries a total of 60 marks.

All questions carry equal marks.

A formula sheet is provided.

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1. (a) Evaluate the following indefinite integrals using integration by parts:

(i) $\int 6xe^{4x}dx$

(ii) $\int 4x^3 \ln 2x\, dx$

(iii) $\int 2x^2 \sin 3x\, dx$

(12 marks)

(b) Estimate the following definite integral using:
(i) the trapezoidal rule with four strips,
(ii) Simpson's rule with four strips.

$$\int_{-1/3}^{1} (1 + 4x + 3x^2)dx$$

Calculate and comment on the percentage errors in your results.

(8 marks)

Total 20 marks

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2. (a) Calculate the distance from the centroid of the Cross Section **G** to the top of the section at **T**.

(5 marks)

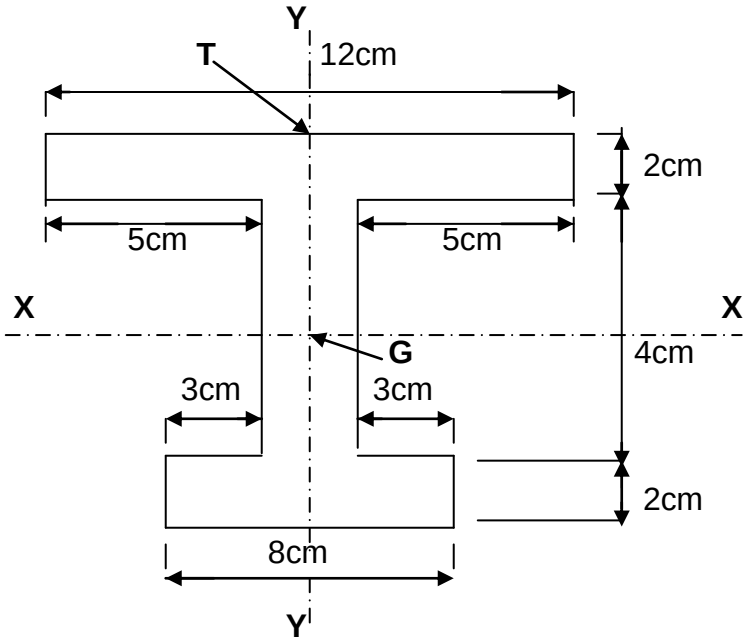
(b) Calculate the Second Moment of Area for this Cross Section

(i) about **X – X**

(10 marks)

(ii) about **Y – Y**.

(5 marks)



Total 20 marks

3. (a) For the matrices

$$A = \begin{pmatrix} 1 & -1 & 2 \\ 2 & -1 & 1 \\ 1 & -1 & 2 \end{pmatrix} \qquad B = \begin{pmatrix} -1 & 2 & 1 \\ -1 & 1 & 2 \\ 1 & -1 & 2 \end{pmatrix}$$

calculate the following:

(i) A + B (ii) AB (iii) BA

Comment on your answers to (ii) and (iii)

(10 marks)

(b) Solve the following system of linear simultaneous equations using matrix inversion:

$$2x_1 - x_2 + 3x_3 = 9$$
$$4x_1 + 3x_2 - x_3 = -1$$
$$3x_1 - 2x_2 + 2x_3 = 9$$

(10 marks)

Total 20 marks

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4. (a) A tensile test on a steel bar gives the results recorded in the table below:

Tensile Load (kN)	4.8	9.3	12.8	17.7	21.6	26.0
Extension (mm)	3.5	8.2	10.1	15.6	18.4	20.8

Determine the least squares regression line for this data.

(10 marks)

(b) 50 mortar cubes were tested and there crushing strengths in N/mm^2 recorded in the table below:

Cube strengths (N/mm^2)

8.0	8.6	8.2	7.5	8.0	9.1	8.5	7.6	8.2	7.8
8.3	7.0	8.1	8.3	8.7	7.8	8.7	8.4	8.5	8.4
7.7	8.4	7.9	8.8	7.2	8.1	7.8	8.2	7.7	7.5
8.1	7.4	8.8	8.0	8.4	8.5	8.1	7.3	9.0	8.6
7.4	8.2	8.4	7.7	8.3	8.2	7.9	8.5	7.9	8.0

(i) Using this data, construct a frequency diagram with approximately seven classes.

(5 marks)

(ii) Draw a ‘less than’ percentage cumulative relative frequency polygon, and from this determine the median and quartile strengths of the cubes.

(5 marks)

Total 20 marks

END OF QUESTIONS

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FORMULA SHEET

1. Quadratic Equations

For the equation $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

2. Laws of Logarithms

$\log AB = \log A + \log B$

$\log \frac{A}{B} = \log A - \log B$

$\log A^P = p \log A$

3. Matrices

For the square matrix A

$$A^{-1} = \frac{\text{Adj}A}{|A|}$$

4. Simpson's Rule

$$\text{Area} = \frac{h}{3}\{(y_1 + y_n) + 4(y_2 + y_4 + \ldots + y_{n-1}) + 2(y_3 + y_5 + \ldots + y_{n-2})\}$$

5. Trapezium Rule

$$\text{Area} = h\left\{\frac{y_0 + y_n}{2} + (y_1 + y_2 + y_3 + \ldots + y_{n-1})\right\}$$

6. Statistics

$$\text{Relative frequency} = \frac{f}{\sum f} \qquad \text{Mean : } \bar{x} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation : } s = \sqrt{\frac{\sum fx^2}{\sum f} - (\bar{x})^2}$$

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Least squares regresstion :

The normal equations are : $\sum y = m\sum x + Nc$

$\sum xy = m\sum x^2 + c\sum x$

Correlation coefficient : $r = \frac{N\sum xy - \sum x \sum y}{\sqrt{\left[N\sum x^2 - (\sum x)^2\right]\left[N\sum y^2 - (\sum y)^2\right]}}$

7. Calculus

If **y = u.v** then $\frac{dy}{dx} = v\frac{du}{dx} + u\frac{dv}{dx}$ If **y** = $\frac{u}{v}$ then $\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$

If **y** is a function of **u** and **u** is a function of **x** then $\frac{dy}{dx} = \frac{dy}{du}.\frac{du}{dx}$

Integration by parts: $\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$

8. Small Increments

If $w=f(x,y,z)$ then $\delta w \approx \frac{\delta w}{\delta x}\delta x + \frac{\delta w}{\delta y}\delta y + \frac{\delta w}{\delta z}\delta z$

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CALCULUS (* the constant of integration has been omitted *)

$\int y\,dx$	y	$\frac{dy}{dx}$
$\frac{x^{n+1}}{n+1}$ $n \neq -1$ $\ln x$ $n = -1$	x^n	nx^{n-1}
$x\ln x - x$	$\ln x$	$\frac{1}{x}$
$\frac{1}{a}e^{ax}$	e^{ax}	ae^{ax}
$\frac{a^x}{\ln a}$	a^x $a > 0$	$a^x \ln a$
$\frac{(ax+b)^{n+1}}{a(n+1)}$ $n \neq -1$ $\frac{1}{a}\ln(ax+b)$ $n = -1$	$(ax+b)^n$	$na(ax+b)^{n-1}$
$\ln f(x)$	$\frac{f'(x)}{f(x)}$	
$-\frac{1}{a}\cos ax$	$\sin ax$	$a\cos ax$
$\frac{1}{a}\sin ax$	$\cos ax$	$-a\sin ax$
$\frac{1}{a}\ln\lvert\sec ax\rvert$	$\tan ax$	$a\sec^2 ax$
$\frac{1}{a}\ln\left\lvert\tan\frac{ax}{2}\right\rvert$	$cosec$ ax -a	$cosec$ ax cot ax
$\frac{1}{a}\ln\lvert\sec ax + \tan ax\rvert$	$\sec ax$	$a\sec ax\tan ax$
$\frac{1}{a}\ln\lvert\sin ax\rvert$	$\cot ax$	$-a\,\mathrm{cosec}^2 ax$
$\frac{1}{a}\cosh ax$	$\sinh ax$	$a\cosh ax$
$\frac{1}{a}\sinh ax$	$\cosh ax$	$a\sinh ax$
$\frac{1}{a}\ln\cosh ax$	$\tanh ax$	$a\,\mathrm{sech}^2 ax$

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$\int y\,dx$	y	$\frac{dy}{dx}$
$\sin^{-1}\left[\frac{x}{a}\right]$	$\frac{1}{\sqrt{a^2-x^2}}$	
$\frac{1}{a}\tan^{-1}\left[\frac{x}{a}\right]$	$\frac{1}{x^2+a^2}$	
$\sinh^{-1}\left[\frac{x}{a}\right]$	$\frac{1}{\sqrt{a^2+x^2}}$	
$\cosh^{-1}\left[\frac{x}{a}\right]$	$\frac{1}{\sqrt{x^2-a^2}}$	
$\cos^{-1}\left[\frac{x}{a}\right]$	$\frac{-1}{\sqrt{a^2-x^2}}$	

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SIGNIFICANCE OF CORRELATION COEFFICIENT

If the value obtained in higher than that shown below, it is significant at the level indicated.

	Level of significance (%)					
One tail	5	2.5	1	0.5	0.1	0.05
Two tail	10	5	2	1	0.2	0.1
Number of pairs of observations						
4	0.900	0.950	0.980	0.990	0.998	0.999
5	0.805	0.878	0.934	0.959	0.986	0.991
6	0.729	0.811	0.882	0.917	0.963	0.974
7	0.669	0.754	0.833	0.875	0.935	0.951
8	0.621	0.707	0.789	0.834	0.905	0.925
9	0.582	0.666	0.750	0.798	0.875	0.898
10	0.549	0.632	0.715	0.765	0.847	0.872
11	0.521	0.602	0.685	0.735	0.820	0.847
12	0.497	0.576	0.658	0.708	0.795	0.823
13	0.476	0.553	0.634	0.684	0.772	0.801
14	0.457	0.532	0.612	0.661	0.750	0.780
15	0.441	0.514	0.592	0.641	0.730	0.760
16	0.426	0.497	0.574	0.623	0.711	0.742
17	0.412	0.482	0.558	0.606	0.694	0.725
18	0.400	0.468	0.543	0.590	0.678	0.708
19	0.389	0.456	0.529	0.575	0.662	0.693
20	0.378	0.444	0.516	0.561	0.648	0.679

* ignoring sign