NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2018-2019

EE2007 / IM2007 – ENGINEERING MATHEMATICS II

April / May 2019 Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 4 pages.
2. Answer ALL questions.
3. All questions carry equal marks.
4. This is a closed book examination.
5. Unless specifically stated, all symbols have their usual meanings.
6. A list of useful formulae is given in the Appendix A on page 4.

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1. (a) Consider the following system of equations:

$$(1+\lambda)x_1 + x_2 + x_3 = 0$$
$$x_1 + (1+\lambda)x_2 + x_3 = 3$$
$$x_1 + x_2 + (1+\lambda)x_3 = \lambda.$$

Determine the values of λ such that the system has

(i) a unique solution,

(ii) no solution,

(iii) many solutions. Also, find these solutions in this case.

(12 Marks)

(b) Suppose that matrices A, B and C satisfy $[I_3 - C^{-1}B]^T C^T A = I_3$, where

$$B = \begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix}, \quad C = \begin{bmatrix} 2 & 1 & 3 \\ 0 & 2 & 1 \\ 0 & 0 & 2 \end{bmatrix}$$

$I_3 - C^{-1} B = [$

Note: Question 1 continues on page 2.

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and I_3 stands for a 3×3 identity matrix. Without calculating the inverse of C, show how A can be determined. Hence determine A.

(8 Marks)

(c) Given that

$$\mathbf{a}=\begin{bmatrix}1\\2\\1\end{bmatrix},\quad \mathbf{b}=\begin{bmatrix}2\\1\\-3\end{bmatrix}\quad \text{and} \quad A=\mathbf{a}\mathbf{b}^T,$$

determine A^{2000}.

(5 Marks)

2. A linear system is given as

$$A\mathbf{x}=\mathbf{b}$$

where

$$A=\begin{bmatrix}2 & 1 & 0\\ a^2 & 4 & 3a\\ 0 & 0 & 2\end{bmatrix},\quad \mathbf{x}=\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix},\quad \mathbf{b}=\begin{bmatrix}b_1\\b_2\\b_3\end{bmatrix}.$$

(a) Use elementary row operations to determine the rank of the matrix A if

(i) $a=2\sqrt{2}$

(ii) $a=4$

Hence, determine the condition imposed on a so that a unique solution can be obtained for any vector $\mathbf{b}$.

(10 Marks)

(b) (i) Determine the eigenvalues of matrix A in terms of a.

(ii) Determine the eigenvectors for the case of $a=\sqrt{3}$.

(11 Marks)

(c) Consider the linear system described by $B\mathbf{x}=\mathbf{b}$, where

$$B=\begin{bmatrix}-5 & 1 & 0\\ a^2 & -3 & 3a\\ 0 & 0 & -5\end{bmatrix}.$$

Note: Question 2 continues on page 3.

By using the results in part (b)(i), determine the values of a so that a unique solution can be obtained.

Hint: First determine the relationship between A and B by subtracting the matrices.

(4 Marks)

3. (a) (i) Using the Cauchy-Riemann equations, comment on the differentiability and analyticity of $f(z) = \cos^2 z$.

(ii) Hence, or otherwise, evaluate $\int_{i}^{2\pi} \cos^2 z \, dz$ along the straight-line path from $z = i$ to $z = 2\pi$.

(12 Marks)

(b) Evaluate $\int_{0}^{\pi} \frac{\sin 2\theta}{2 + \cos 2\theta} d\theta$.

(13 Marks)

4. (a) Evaluate the line integral $\int_C \mathbf{F} \cdot d\mathbf{r}$ for $\mathbf{F}(x, y, z) = xy\,\mathbf{i} + \cos y\,\mathbf{j} + e^z\,\mathbf{k}$, along the straight-line path C from (3, 0, -2) to (4, 2, -1).

(8 Marks)

(b) Using a suitable spherical surface parameterization, evaluate $\iint_S curl\,\mathbf{F} \cdot d\mathbf{A}$ for surface $S: x^2 + y^2 + z^2 = a^2,\ x \geq 0$, and $\mathbf{F}(x, y, z) = -z\,\mathbf{j} + y\,\mathbf{k}$.

(10 Marks)

(c) Using Stokes' Theorem, evaluate $\iint_S curl\,\mathbf{F} \cdot d\mathbf{A}$ for surface $S: x^2 + y^2 + z^2 = a^2,\ x \geq 0$, and $\mathbf{F}(x, y, z) = -z\,\mathbf{j} + y\,\mathbf{k}$.

(7 Marks)

b) $x = a \cos u \sin v$

$y = a \sin u \sin v$

$z = a \cos v$

$\nabla \times F = i\left(\frac{d(y)}{dy} - \frac{d(-z)}{dz}\right) - j\left(\frac{d}{dx} - \frac{d}{dz}\right) + k\left(\frac{d}{dx} - \frac{d}{dy}\right)$

Appendix A

1. Complex Analysis

(a) Complex Power: $z^c = e^{c \ln z}$

(b) De Moivre's Formula: $(\cos\theta + i\sin\theta)^n = \cos n\theta + i\sin n\theta$.

(c) Cauchy-Riemann equations:
$u_x = v_y,\ v_x = -u_y,$ or $u_r = \frac{1}{r}v_\theta,\ v_r = \frac{-1}{r}u_\theta$

(d) Cauchy Integral Formula:
$$\int_C \frac{f(z)}{(z-z_o)^m}\,dz = \frac{2\pi i}{(m-1)!}\,\frac{d^{(m-1)}}{dz^{(m-1)}} f(z)\Big|_{z=z_o}$$

2. Vector Analysis. Let $\mathbf{F} = F_1\mathbf{i} + F_2\mathbf{j} + F_3\mathbf{k}$.

(a) Scalar Triple Product: $\mathbf{a}\cdot(\mathbf{b}\times\mathbf{c}) = \mathbf{c}\cdot(\mathbf{a}\times\mathbf{b}) = \mathbf{b}\cdot(\mathbf{c}\times\mathbf{a})$

(b) Gradient: $\nabla f = \frac{\partial f}{\partial x}\mathbf{i} + \frac{\partial f}{\partial y}\mathbf{j} + \frac{\partial f}{\partial z}\mathbf{k}$

(c) Divergence: $\nabla\cdot\mathbf{F} = \frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z}$

(d) Curl: $\nabla\times\mathbf{F} = \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_1 & F_2 & F_3 \end{vmatrix}$

(e) Divergence Theorem: $\iiint_T \nabla\cdot\mathbf{F}\,dv = \oiint_S \mathbf{F}\cdot\mathbf{n}\,dA$

(f) Stokes Theorem: $\iint_S (\nabla\times\mathbf{F})\cdot\mathbf{n}\,dA = \oint_C \mathbf{F}\cdot d\mathbf{r}$

END OF PAPER

1 a) $\begin{bmatrix} (1+\lambda) & 1 & 1 \\ 1 & (1+\lambda) & 1 \\ 1 & 1 & (1+\lambda) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 3 \\ \lambda \end{bmatrix}$

$$\left[\begin{array}{ccc|c} (1+\lambda) & 1 & 1 & 0 \\ 1 & (1+\lambda) & 1 & 3 \\ 1 & 1 & (1+\lambda) & \lambda \end{array}\right]$$

$$R_1 \Leftrightarrow R_3 \left[\begin{array}{ccc|c} 1 & 1 & (1+\lambda) & \lambda \\ 1 & (1+\lambda) & 1 & 3 \\ (\lambda+1) & 1 & 1 & 0 \end{array}\right]$$

$$\begin{matrix} R_2 \Leftarrow R_2 - R_1 \\ R_3 \Leftarrow R_3 - R_1(\lambda+1) \end{matrix} \left[\begin{array}{ccc|c} 1 & 1 & (1+\lambda) & \lambda \\ 0 & \lambda & -\lambda & 3-\lambda \\ 0 & -\lambda & -2\lambda-\lambda^2 & -\lambda(\lambda+1) \end{array}\right] \Rightarrow R_3 \Leftarrow R_3 + R_2 \left[\begin{array}{ccc|c} 1 & 1 & (1+\lambda) & \lambda \\ 0 & \lambda & -\lambda & 3-\lambda \\ 0 & 0 & -3\lambda-\lambda^2 & 3-2\lambda-\lambda^2 \end{array}\right]$$

i) Unique solution condition

① $-3\lambda - \lambda^2 \neq 0$

$(-3-\lambda)\lambda \neq 0$

$\lambda_1 \neq 0$ and $\lambda_2 \neq -3$

(ii) no solution

① $-3\lambda - \lambda^2 = 0$ $\cap$ ② $3 - 2\lambda - \lambda^2 \neq 0$

$\lambda = 0 \quad \lambda = -3$ $\qquad (3+\lambda)(1-\lambda) \neq 0$

$\lambda \neq -3 \quad \lambda \neq 1$

the solution is $\lambda_1 = 0$

iii) many solution

① $-3\lambda - \lambda^2 = 0$ | $\cap$ | ② $3 - 2\lambda - \lambda^2 = 0$

$\lambda = 0 \quad \lambda = -3$ $\qquad \lambda = -3 \quad \lambda = 1$

the solution is $\lambda = -3$

b) $[C^{-1}[C \cdot I_3 - B]]^T C^T A = I_3$

$[C - B]^T C^{-T} C^T A = I_3$

$[C - B]^T I_3 A = I_3$

$I_3 \cdot A = [C - B]^{-T} \cdot I_3$

$A = [C - B]^{-T} = \begin{bmatrix} 1 & 0 & 0 \\ -2 & 1 & 0 \\ 1 & -2 & 1 \end{bmatrix}$

1c) $A = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [2 \ 1 \ -3]$

$A^2 = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [2 \ 1 \ -3] \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [2 \ 1 \ -3] = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [1] [2 \ 1 \ -3]$

$\vdots$

$A^{2000} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [1] \ldots [1] [2 \ 1 \ -3] = \begin{bmatrix} 2 & 1 & -3 \\ 4 & 2 & -6 \\ 2 & 1 & -3 \end{bmatrix}$

* noted that $[1]$ is scalar

2a) i) $a = 2\sqrt{2}$

$\begin{bmatrix} 2 & 1 & 0 \\ 8 & 4 & 6\sqrt{2} \\ 0 & 0 & 2 \end{bmatrix} \underset{E_1 : R_2 \leftarrow R_2 - 4R_1}{\sim} \begin{bmatrix} 2 & 1 & 0 \\ 0 & 0 & 6\sqrt{2} \\ 0 & 0 & 2 \end{bmatrix} \underset{E_2 : R_3 \leftarrow R_3 - \frac{2}{6\sqrt{2}} R_2}{\sim} \begin{bmatrix} 2 & 1 & 0 \\ 0 & 0 & 6\sqrt{2} \\ 0 & 0 & 0 \end{bmatrix}$

Rank of matrix $A = 1$

ii) $a = 4$

$\begin{bmatrix} 2 & 1 & 0 \\ 16 & 4 & 12 \\ 0 & 0 & 2 \end{bmatrix} \underset{E_1 : E_2 \leftarrow E_2 - 8E_1}{\sim} \begin{bmatrix} 2 & 1 & 0 \\ 0 & -4 & 12 \\ 0 & 0 & 2 \end{bmatrix}$

Rank of matrix $A = 3$

$\left[\begin{array}{ccc|c} 2 & 1 & 0 & b_1 \\ a^2 & 4 & 3a & b_2 \\ 0 & 0 & 2 & b_3 \end{array}\right]$

$R_1 \leftarrow 0.5R_1 \left[\begin{array}{ccc|c} 1 & 0.5 & 0 & 0.5b_1 \\ a^2 & 4 & 3a & b_2 \\ 0 & 0 & 2 & b_3 \end{array}\right]$

$R_2 \leftarrow R_2 - a^2 R_1 \left[\begin{array}{ccc|c} 1 & 0.5 & 0 & 0.5b_1 \\ 0 & 4-0.5a^2 & 3a & b_2 - 0.5b_1 \\ 0 & 0 & 2 & b_3 \end{array}\right]$

$4 - 0.5a^2 \neq 0$

$(2\sqrt{2} + a)(2\sqrt{2} - a) = 0$

$a_1 \neq 2\sqrt{2}$ and $a_2 \neq -2\sqrt{2}$

b i) $\begin{vmatrix} \lambda - 2 & -1 & 0 \\ -a^2 & \lambda - 4 & -3a \\ 0 & 0 & \lambda - 2 \end{vmatrix} = 0$

$(\lambda - 2)^2 (\lambda - 4) - (\lambda - 2) a^2 = 0$

$(\lambda - 2)^2 (\lambda^2 - 6\lambda + 8 - a^2) = 0$

$\lambda = 2$ and $\lambda = \frac{6 + \sqrt{36 - 4(8 - a^2)}}{2}$ and $\lambda = \frac{6 - \sqrt{36 - 4(8 - a^2)}}{2}$

ii) $\lambda = 2$

$\begin{bmatrix} 0 & -1 & 0 \\ -3 & -2 & -3\sqrt{3} \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$x_2 = 0$, $x_1 + \sqrt{3} x_3 = 0$

$V_1 = \begin{bmatrix} -\sqrt{3} \\ 0 \\ 1 \end{bmatrix}$

$\lambda = \frac{6 + \sqrt{36 - 4(8 - 3)}}{2} = 5$

$\begin{bmatrix} 3 & -1 & 0 \\ -3 & 1 & -3\sqrt{3} \\ 0 & 0 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$\begin{bmatrix} 3 & -1 & 0 \\ 0 & 0 & -3\sqrt{3} \\ 0 & 0 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$X_3 = 0$, $3X_1 - X_2 = 0$

$V_2 = \begin{bmatrix} 1 \\ 3 \\ 0 \end{bmatrix}$

$\lambda = \frac{6 - \sqrt{36 - 4(8 - 3)}}{2} = 1$

$\begin{bmatrix} -1 & -1 & 0 \\ -3 & -3 & -3\sqrt{3} \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0$

$X_1 + X_2 = 0$, $X_3 = 0$

$V_3 = \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix}$

2 c)

3 a) i) $\cos^2 z = \frac{(e^{iz}+e^{-iz})^2}{4} = \frac{(e^{i(x+iy)}+e^{-i(x+iy)})^2}{4} = \frac{(e^{ix}\cdot e^{-y}+e^{-ix}\cdot e^{y})^2}{4} =$

$= \frac{1}{4}(e^{-2y}\cdot e^{2ix} + 2 + e^{-2ix}\cdot e^{2y})$

$= \frac{1}{4}[e^{-2y}\cos 2x + e^{-2y}\sin 2x\, i + 2 + e^{2y}\cos 2x - e^{2y} i \sin 2x)$

~~let: U =~~ let:

$U = \frac{1}{4}(e^{-2y}\cos 2x + 2 + e^{2y}\cos 2x)$, $V = \frac{1}{4}(e^{-2}\sin 2x + e^{2y}(-\sin 2x))$

$U_x = \frac{1}{4}(-2e^{-2y}\sin 2x - 2e^{-2y}\sin 2x)$, $V_x = \frac{1}{4}(2\cdot e^{-2y}\cos 2x - 2e^{2y}\cos 2x)$

$U_y = \frac{1}{4}(-2e^{-2y}\cos 2x + 2e^{2y}\cos 2x)$, $V_y = \frac{1}{4}(-2e^{-2y}\sin 2x - 2e^{2y}\sin 2x)$

Condition

$U_x = V_y$

$\frac{1}{4}(-2e^{-2y}\sin 2x - 2e^{-2y}\sin 2x) = \frac{1}{4}(-2e^{-2y}\sin 2x - 2e^{-2y}\sin 2x)$

satisfied

$U_y = -V_x$

$\frac{1}{4}(-2e^{-2y}\cos 2x + 2e^{2y}\cos 2x) = -\frac{1}{4}(2\cdot e^{-2y}\cos 2x - 2e^{2y}\cos 2x)$

satisfied

f(z) is analitic and differentiable at every point

ii) $\boxed{-1+2\cos^2 z = \cos 2z \quad \cos^2 z = \frac{\cos 2z + 1}{2}}$ $= \int_i^{2\pi} \frac{\cos 2z + 1}{2} dz$

$= \frac{1}{2}\left(\frac{1}{2}\sin 2z + z\right)\Big|_i^{2\pi}$

$= \frac{1}{2}\left(\frac{1}{2}\sin 4\pi + 2\pi\right) - \frac{1}{2}\left(\frac{1}{2}\sin 2i - i\right)$

$= \frac{1}{2}\left(2\pi - \frac{1}{2}\sin 2i - i\right)$

b) $z = e^{i2\theta}$

$\frac{dz}{2iz} = d\theta$

$\frac{1}{2i}\int_0^{\pi} \frac{(z-\frac{1}{z})}{2+\frac{1}{2}(z+\frac{1}{z})}\cdot\frac{dz}{2iz} = \int_0^{\pi} \frac{z^2-1}{z^2+4z+1}\cdot\frac{dz}{(2i)^2\, 2z}$

$\int_0^{\pi} -\frac{z^2-1}{z^2+4z+1}\cdot\frac{dz}{2z}$

$\oint \frac{-\frac{z^2-1}{(z+2+\sqrt{3})2z}}{z-(-2+\sqrt{3})} + \frac{1}{2}\oint\frac{-\frac{z^2-1}{z^2+4z+1}}{z}$

$\pi i\left[\frac{-z^2-1}{(z+2+\sqrt{3})\cdot 2z}\right]\Big|_{z=-2+\sqrt{3}} + \pi i\left(-\frac{z^2+1}{2(z^2+4z+1)}\right)\Big|_{z=1} = 0$

ADSO

4 a) $\nabla \times F = i\left(\frac{d(e^z)}{dy} - \frac{d(\cos y)}{dz}\right) + (-j)\left(-\frac{d(xy)}{dz} + \frac{de^z}{dx}\right) + k\left(\frac{d\cos y}{dx} - \frac{d(xy)}{dy}\right)$

$= -xk$

$x = 3+t$

$y = 2t$

$z = -2+t \qquad 0 \le t \le 1$

$r = (3+t)i + 2tj + (-2+t)k$

$dr = (i + 2j + k)dt$

$\int_0^1 [(3+t)2ti + \cos 2tj + e^{-2+t}k] \cdot (i+2j+k)\,dt$

$\int_0^1 [(3+t)2t + 2\cos 2t + e^{-2+t}]dt$

$3t^2 + \frac{2}{3}t^3 + \sin 2t + e^{-2+t} \Big|_0^1$

$3 + \frac{2}{3} + \sin 2 + e^{-1} - e^{-2}$

$\frac{11}{3} + \sin 2 + \frac{e-1}{e^2}$

b) $x = a\cos u \cdot \sin v$; $-\frac{1}{2}\pi \le u \le \frac{1}{2}\pi$

$y = a\sin u \cdot \sin v$; $0 \le v \le \pi$

$z = a\cos v$

$r_u = a\cos u \cdot \sin v \cdot i + a\cos u \sin v\, j$

$r_v = a\cos u \cos v i + a\sin u \cos v - a\sin v k$

$N = +a^2 \sin v\,(\cos u \sin v\, i + \sin u \sin v\, j + \cos v\, k)$

$\nabla \times f = i\left(\frac{d(y)}{dy} - \frac{d(-z)}{dz}\right) - j\left(\frac{d(y)}{dx} - \frac{d(0)}{dz}\right) + k\left(\frac{d(-z)}{dx} - \frac{d(0)}{dy}\right)$

$= i(1-(-1)) - j(0-0) + k(0-0)$

$= 2i$

$\iint \nabla \times F \cdot dA = \iint \nabla \times F \cdot N(u,v)\,du\,dv$

$\int_0^{\pi}\int_{-\frac{1}{2}\pi}^{\frac{1}{2}\pi} \begin{pmatrix} 2i \\ 0 \\ 0 \end{pmatrix} \cdot a^2 \sin v \cdot \begin{pmatrix} \cos u \sin v \\ \sin u \sin v \\ \cos v \end{pmatrix} du\,dv = 2a^2 \int_0^{\pi}\int_{-\frac{1}{2}\pi}^{\frac{1}{2}\pi} \sin^2 v \cos u\,du \cdot dv$

$= 2a^2(+1+1)\int_0^{\pi} \sin^2 v\,dv = 2a^2(2) \cdot \frac{1}{2}\pi = 2\pi a^2$

c) $x = 0$; $y = a\cos\theta$; $z = a\sin\theta$; $0 \le \theta \le 2\pi$

$r = a\cos\theta j + a\sin\theta k$; $dr = -a\sin\theta j + a\cos\theta k$

$= \int_0^{2\pi} \underset{F(x,y,z)}{\begin{pmatrix} -a\sin\theta \\ a\cos\theta \end{pmatrix}} \cdot \underset{dr}{\begin{pmatrix} -a\sin\theta \\ a\cos\theta \end{pmatrix}} d\theta = \int_0^{2\pi} a^2(\underbrace{\sin^2\theta + \cos^2\theta}_{1})\,d\theta$

$= a^2 \cdot \theta \Big|_0^{2\pi} = 2\pi a^2$

Date No.

2. (c)(i)

```
AREA   anotherProgram, CODE, READONLY
       ENTRY
       MOV r0, #10        ⇒ MOV r0, #3
       MOV r2, #0
       ADD r4, #0    X      MOV r4, #0 (?)
Loop1
       MOV r3, #0
       ADD r2, r2, #1
       MOV r1, #1
Loop2
       CMPS r1, #5    X    CMP r1, #5
       BGT  somewhere
       MUL  r3, r2, r1
       ADD  r4, r4, r3
       ADD  r1, r1, #1
       B    Loop2
somewhere
       SUB  r0, r0, #1   ⇒ ADD r0, r0, #1
       CMPS r0, #3     X  CMP r0, #3  ⇒ CMP r0, #10
       BGT  Loop1      ⇒ BLT Loop1
Stop   B    Stop
       END
```

(ii) Counter for outer loop :
r0 (i)
Counter for inner loop :
r1 (j)
i = 10
j = 1
for (i=10; i>3; i--)
for (j=1; j>5; j++)
Outer loop = 7x
Inner loop = 5x
Total loop = 7x5
= 35 times
(Not sure)

(iii) Look at the lines with "⇒"
(Not sure)

3. (a) (i) 56 bytes = 28 half words
12 x 4 bytes + 4 x 2 bytes = 56 bytes

(ii) if R2 > R3 → update R2   if R4 < R3 → update R4
R2 → store the smallest number   R4 → store the biggest number
R2 = 0x88991122   R4 = 0x76543210

(iii) R0 → loop counter   R1 → pointer which points to memory address   R3 → temporary variable to store data from memory

(iv)
DCD 0x2001, 0x0010, 0x3210
DCD 0x0019, 0x1122, 0x5678
DCD 0x1122, 0x100, 0x1100
DCD 0x6633, 0x763, 0x646
DCW 32000, 123, -654, 888

(v) Total memory = 108 bytes

3. (b) Starting address of FIQ : 0X0000001C

Starting address of IRQ : <32MB (Unsure)

Modification of the link register :

For FIQ : lr = lr - 4 (it also holds for IRQ). lr = PC - 4

3. (c) R3 → 0x7FFFFFFF R2 → 0x88779955 R1 → 0x40000FF8 R0 → 0x2323888

sp → 0x40000FF0

4. (a) Assembly code

```
    AREA   arithmetic, CODE, READONLY
    ENTRY
    ADR R4, table        ; point to the address of the first element of 'table'
    LDR R0, [R4]         ; load value of a
    LDR R1, [R4, #4]     ; load value of b
    LDR R2, [R4, #8]     ; load value of c
    ADD R5, R0, R1
    SUB R5, R5, R2
    STR R5, [R4, #12]    ; to store the value of x in memory
Stop B Stop
    SPACE
table DCD 10, 20, 6
    END
```

Inline Assembly Function

```
__inline int arithmetic (int a, int b, int c) {
    int x, temp;
    __asm {
        ADD temp, a, b
        SUB x, temp, c };
    return x;
}
```

4. (b)

```
    MOV r7, r1
    LSR r7, #4          } (i)
    ADD r3, r4, r7

    PUSH {r0-r4, r8, PC}  (ii)

    MOV r7, r4
    LSL r7, #2          } (iii)
    LDR r0, [r3, r7]

    STR r0, [r2], #2      (iv)

loop SUB r3, r5
     CMP r3, #0
     BGE Greater
     BLT Stop           } (V)
Greater ADD r2, #1
     B Loop
Stop B Stop
```