# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2012/2013

| | | |
|---|---|---|
| COURSE NAME | : | URBAN STORMWATER MANAGEMENT |
| COURSE CODE | : | BFW 4053 |
| PROGRAMME | : | 4 BFF |
| EXAMINATION DATE | : | DECEMBER 2012/JANUARY 2013 |
| DURATION | : | 3 HOURS |
| INSTRUCTIONS | : | ANSWER **FIVE (5)** QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

**Q1** (a) Discuss the new development aspect that is outlined in Urban Stormwater Management Manual for Malaysia (USMM).

(5 marks)

(b) The Department of Irrigation and Drainage which is under the Federal Government is responsible in managing urban stormwater in Malaysia. From your point of views, discuss the economic values of having a good stormwater management in practice.

(5 marks)

(c) From your personal judgment, how can you relate urbanization with the increment of the stromwater runoff and state **four (4)** examples of the transformation area to urban that is typical found in Malaysia.

(5 marks)

(d) In some countries where heavy downpours happened so frequently will cause the stormwater-associated problems. Explain these problems.

(5 marks)

**Q2** (a) Define return period (ARI) and state **four (4)** factors in considering the return period design.

(3 marks)

(b) An annual maximum series of 15 years of rainfall depth that occurred within 30 to 240 minutes are given in the descending order as stated in **Table Q2 (a)**. **Table Q2 (b)** shows the frequency factor, K for the extreme distribution type I – Appendix I. Determine the rainfall depth that occurs in 30, 60, 120 and 240 minutes time and the average intensity that is associated with 5, 10, and 25 years of ARI. Assume that the extreme value type I distribution is fitted with the annual maximum series.

**Table Q2 (a)**

| $T_d$ | P (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 30 min | 20.2 | 34.3 | 22.3 | 12.5 | 38.9 | 50.1 | 32.2 | 8.4 |
| | 34.5 | 11.9 | 18.7 | 5.2 | 8.8 | 10.1 | 17.0 | |
| 60 min | 35.3 | 41.0 | 26.3 | 15.7 | 44.5 | 50.4 | 36.5 | 11.0 |
| | 34.5 | 23.7 | 33.0 | 10.4 | 17.5 | 20.3 | 20.4 | |
| 120 min | 40.8 | 45.2 | 35.9 | 23.5 | 50.2 | 50.7 | 36.5 | 12.7 |
| | 34.5 | 31.5 | 33.0 | 15.6 | 23.7 | 30.1 | 24.9 | |
| 240 min | 53.0 | 49.5 | 54.9 | 46.0 | 67.2 | 51.6 | 38.2 | 25.4 |
| | 53.3 | 31.5 | 33.0 | 31.2 | 28.9 | 54.8 | 43.0 | |

(10 marks)

(c) Based on **Q2 (b)** construct the Intensity – Duration – Frequency (IDF) curve for 5-year, 10-year and 25-year frequencies.

(7 marks)

**Q3** (a) Explain briefly **three (3)** aspects of the limitation of the Rational Method.

(6 marks)

(b) **Figure Q3** shows an area, situated in Sri Gading, Batu Pahat, Johor, to be developed. The drainage system to be used is the closed (piped) drainage system.

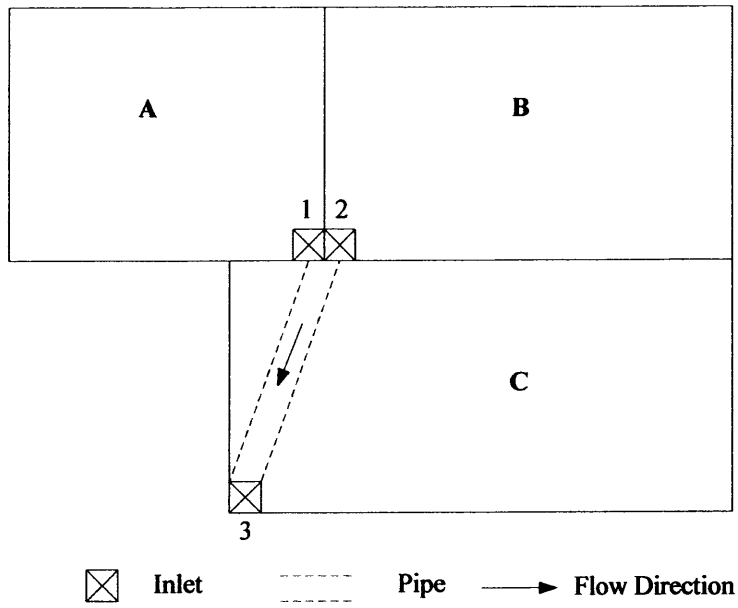



**Figure Q3**

The characteristics of the sub-areas are given as in the **Table Q3 (a)** :-

**Table Q3 (a)**

| Catchment | A | B | C |
|---|---|---|---|
| Area (hectares) | 2 | 4 | 6 |
| Inlet | 1 | 2 | 3 |
| Runoff coefficient | 0.6 | 0.5 | 0.45 |
| Inlet time (minute) | 5 | 6 | 7 |
| Pipe length (m) | 146 | | |
| Pipe velocity (m/s) | 0.61 | | |

Using the Rational Method as outlined in the Urban Stormwater Management Manual for Malaysia, estimate the discharges in $m^3/s$ into each inlet and the required discharge capacity for pipe segment. Take value of ${}^2P_{24hr}$ as 110 (West Coast) and assume that the following equation is applicable for the storm durations :-

$$\ln I = 5.2470 + 0.2916 \ln t - 0.1575(\ln t)^2 + 0.0074(\ln t)^3$$

in which $t$ is the storm duration in minutes, and $I$ is the rainfall intensity in mm/hr.

(14 marks)

**Q4** (a) Briefly explain the purpose of detention facilities.

(3 marks)

(b) List down **five (5)** benefits of retention facilities for stormwater management.

(5 marks)

(c) Compare **two (2)** difference functions between the detention and retention ponds from engineering purpose.

(4 marks)

(d) A wet Extended Detention pond sized for the required water quality volume will be used to illustrate the sizing procedure for an extended-detention orifice. Given the following information, calculate the required orifice size for water quality design. Given: water quality volume (WQv) = 937.46 $m^3$, Maximum hydraulic head ($H_{max}$) = 1.524 m (from stage vs. storage data), C = 0.6 and $Q = CA(2gH)^{0.5}$.

( 8 marks)

**Q5** (a) Identify the major inlet types as shown in **Figure Q5 (a)** by labeling the names of these structures respectively.

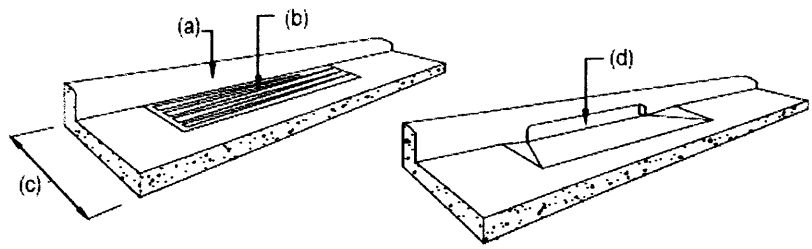



**Figure Q5 (a)**

(2 marks)

(b) A triangular gutter has a longitudinal slope of $S_L$ = 0.01, cross slope of $S_x$= 0.02, and Manning roughness of $n$ = 0.016. Determine the flow depth and spread at a discharge of 0.186 $m^2/s$. Given that $k_n$ = 1.0 $m^{1/3}/s$.

(6 marks)

(c) A composite gutter section has the dimension of W = 0.5 m, $S_L$ = 0.08, $S_x$ = 0.02, and a = 0.05 m. The Manning roughness factor is $n$ = 0.016. Estimate the discharge in the gutter at a spread, T = 2.0 m and $k_n$ = 1.0 $m^{1/3}/s$.

(6 marks)

(d) A V-shape swale often has left and right side slopes that are equal. Explain on how the flow rate and depth would change if the both side slopes were changed to 0.05. Given that $n$ = 0.016, $S_L$ = 0.01, T = 2.44 m and $k_n$ = 1.0 $m^{1/3}/s$. Sketch the cross section of this swale with the particular dimensions.

(6 marks)

**Q6** (a) Identify **four (4)** pollutants that are likely to be found in urban stormwater and probable source of the pollutants.

(4 marks)

(b) "*Vegetative practices are usually employed in conjunction with other BMPs , since the vegetative practices alone do not have the capability of entirely controlling the increased runoff and pollutant export from a site*". Briefly appraise this statement regarding the stormwater management practices and its application.

(5 marks)

(c) A sand filter BMP will be designed to treat the first 0.0127 m of runoff per impervious $m^2$ from a 60,702.85 $m^2$ commercial site, which is 85 % impervious. Determine the dimensions of the sand bed using K = 1.07 m/day, $T_d$ = 40 hr = 1.67 days, and Z = 0.46 m. The sedimentation basin will be sized to release the water quality volume over a 24 hr period.

(8 marks)

(d) Briefly your opinion for **three (3)** actions on principles of Erosion and Sediment Control (ESC) to handle the problems according to site conditions.

(3 marks)

**S1** (a) Bincangkan aspek pembangunan baru yang digariskan di dalam Manual Pengurusan Air Ribut Bandar untuk Malaysia (MSMA).

(5 markah)

(b) Jabatan Pengairan dan Saliran di bawah Kerajaan Persekutuan bertanggungjawab dalam pengurusan air ribut di Malaysia. Pada pandangan anda, bincangkan nilai-nilai ekonomi dengan adanya pengurusan air ribut yang baik secara praktikal.

(5 markah)

(c) Pada pertimbangan peribadi anda, bagaimana anda boleh kaitkan perbandaran dengan bertambahnya air ribut permukaan dan nyatakan **empat (4)** contoh penukaran kawasan kepada kawasan bandar yang biasa ditemui di Malaysia.

(5 markah)

(d) Di sesetengah negara di mana hujan yang lebat berlaku secara kerap mengakibatkan masalah membabitkan air ribut. Terangkan masalah-masalah ini.

(5 markah)

**S2** (a) Takrifkan kala kembali dan nyatakan **empat (4)** faktor pertimbangan dalam memilih rekabentuk kala kembali.

(3 markah)

(b) Satu siri maksimum tahunan 15 tahun bagi kedalaman hujan yang berlaku selama 30 sehingga 240 minit diberi dalam urutan menurun seperti yang tertera di dalam **Jadual S2 (a)**. **Jadual S2 (b)** menunjukkan pekali kekerapan K untuk taburan nilai lampau jenis I – Lampiran I. Tentukan kedalaman hujan yang berlaku selama 30, 60, 120 and 240 minit dan purata keamatan yang dikaitkan dengan kala kembali 5, 10 dan 25 tahun. Anggap bahawa taburan nilai lampau jenis I sepadan dengan siri maksimum tahunan tersebut.

**Jadual S2 (a)**

| $T_d$ | P (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 30 min | 20.2 | 34.3 | 22.3 | 12.5 | 38.9 | 50.1 | 32.2 | 8.4 |
| | 34.5 | 11.9 | 18.7 | 5.2 | 8.8 | 10.1 | 17.0 | |
| 60 min | 35.3 | 41.0 | 26.3 | 15.7 | 44.5 | 50.4 | 36.5 | 11.0 |
| | 34.5 | 23.7 | 33.0 | 10.4 | 17.5 | 20.3 | 20.4 | |
| 120 min | 40.8 | 45.2 | 35.9 | 23.5 | 50.2 | 50.7 | 36.5 | 12.7 |
| | 34.5 | 31.5 | 33.0 | 15.6 | 23.7 | 30.1 | 24.9 | |
| 240 min | 53.0 | 49.5 | 54.9 | 46.0 | 67.2 | 51.6 | 38.2 | 25.4 |
| | 53.3 | 31.5 | 33.0 | 31.2 | 28.9 | 54.8 | 43.0 | |

(10 markah)

(c) Berpandukan **S2 (b)** bina lengkung Keamatan – Tempoh – Kekerapan (IDF) untuk kekerapan 5-tahun, 10-tahun dan 25-tahun.

(7 markah)

S3 (a) Jelaskan dengan ringkas **tiga (3)** aspek keterbatasan Kaedah Rasional.

(6 markah)

(b) **Rajah S3** menunjukkan sebuah kawasan, terletak di Sri Gading, Batu Pahat, Johor ingin untuk dibangunkan. Sistem perparitan yang digunakan ialah sistem penyaliran bertutup (berpaip).

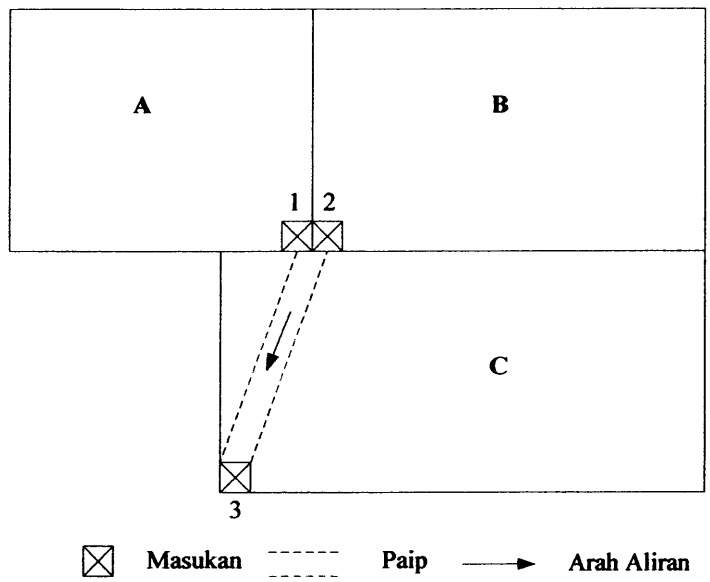



**Figure Q3**

Ciri-ciri sub-kawasan diberi seperti di dalam **Jadual S3 (a)** :-

**Jadual S3 (a)**

| Tadahan | A | B | C |
|---|---|---|---|
| Luas(hektar) | 2 | 4 | 6 |
| Masukan | 1 | 2 | 3 |
| Pekali air larian | 0.6 | 0.5 | 0.45 |
| Masa masukan(minit) | 5 | 6 | 7 |
| Panjang paip(m) | 146 | | |
| Halaju paip(m/s) | 0.61 | | |

Menggunakan Kaedah Rasional seperti digariskan di dalam Manual Pengurusan Air Ribut Bandar untuk Malaysia, anggarkan kadar alir dalam $m^3/s$ yang memasuki setiap masukan dan kapasiti kadar alir yang diperlukan oleh segmen paip. Ambil nilai ${}^2P_{24hr}$ sebagai 110 (Pantai Barat) dan anggap bahawa persamaan berikut dapat digunakan untuk tempoh hujan :-

$$\ln I = 5.2470 + 0.2916 \ln t - 0.1575(\ln t)^2 + 0.0074(\ln t)^3$$

dengan $t$ ialah tempoh ribut dalam minit, dan $I$ ialah keamatan hujan dalam mm/jam.

(14 markah)

**S4** (a) Terangkan dengan ringkas tujuan kolam tadahan.

(3 markah)

(b) Senaraikan **lima (5)** faedah kolam tadahan terhadap pengurusan air ribut.

(5 markah)

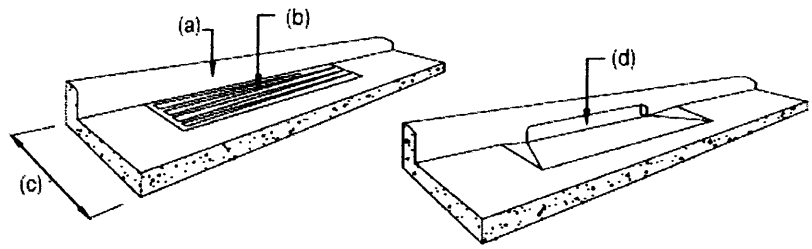
(c) Bandingkan **dua (2)** perbezaan fungsi di antara kolam takungan dan kolam tahanan dari segi tujuan kejuruteraan.

(4 markah)

(d) Sebuah kolam takungan tambahan yang basah direkabentuk untuk memenuhi keperluan isipadu kualiti air yang mana ia digunakan untuk merekabentuk kolam takugan-berorifis. Kirakan ukuran paip orifis yang diperlukan bagi memenuhi rekabentuk kualiti air. Diberi isipadu kualiti air (WQv) = 937.46 $m^3$, ketinggian maksimum hidraulik ($H_{max}$) = 1.524 m (dari data kedalaman melawan simpanan), C = 0.6 dan $Q = CA(2gH)^{0.5}$.

(8 markah)

**S5** (a) Kenalpasti jenis laluan air utama seperti telah ditunjukkan pada **Rajah S5 (a)** dengan melebelkan nama struktur masing-masing.




**Rajah S5 (a)**

(2 markah)

(b) Satu saluran segitiga mempunyai kecerunan memanjang $S_L$ = 0.01, kecerunan melintang $S_x$ = 0.02, dan rintangan Manning $n$ = 0.016. Kirakan kedalaman aliran dan lebar bukaan pada kadaralir 0.186 $m^3/s$. Diberi $k_n$ = 1.0 $m^{1/3}/s$.

(6 markah)

(c) Satu keratan saluran rencam yang berdimensi W = 0.5 m, $S_L$ = 0.08, $S_x$ = 0.02, dan a = 0.05 m. Faktor kerintangan Manning $n$ = 0.016. Anggarkan aliran di dalam saluran dengan T = 2.0 m and $k_n$ = 1.0 $m^{1/3}/s$.

(6 markah)

(d) Saliran berumput berbentuk V mempunyai kecerunan sisi kiri dan kanan yang sama. Terangkan bagaimana kadar aliran dan kedalaman berubah jika kedua-dua cerun sisi diubah kepada 0.005. Diberi $n$ = 0.016, $S_L$ = 0.01, T = 2.44 m dan $k_n$ = 1.0 $m^{1/3}/s$. Lakarkan keratan rentas saluran berumput ini dengan perincian dimensi.

(6 markah)

**S6** (a) Kenalpasti **empat (4)** pencemaran yang sering ditemui dalam air ribut bandaran dan punca kemungkinan ia tercemar.

(4 markah)

(b) *"Vegetative practices are usually employed in conjunction with other BMPs, since the vegetative practices alone do not have the capability of entirely controlling the increased runoff and pollutant export from a site"*. Tafsirkan secara ringkas kenyataan ini berdasarkan pengurusan air ribut bandaran yang dipraktik dan telah diguna pakai.

(5 markah)

(c) Satu Penapis BMP berpasir akan direkabentuk untuk merawat simbahan pertama 0.0127 m larian permukaan per kawasan tidak telap $m^2$ daripada 60,702.85 $m^2$ adalah tapak komersial, yang mana 85 % adalah kawasan tidak telap. Kirakan dimensi tapak penapis pasir menggunakan K = 1.07 m/hari, $T_d$ = 40 jam = 1.67 hari, dan Z = 0.46 m. Kolam mendapan akan direkabentuk untuk melepaskan isipadu kualiti air melebihi tempoh 24 jam.

(8 markah)

(d) Berikan pandangan anda secara ringkas **tiga (3)** tindakan terhadap prinsip Kawalan Hakisan dan Mendapan bagi mengatasi masalah ini berdasarkan keadaan di tapak.

(3 markah)

**APPENDIX I**

**FINAL EXAMINATION**

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 4 BFF
COURSE NAME : URBAN STORMWATER MANAGEMENT COURSE CODE : BFW 40503

## TABLE

Table Q2 (b) : Frequency factor, K for the extreme distribution type I

| | $T_r$ (year) | | | | |
|---|---|---|---|---|---|
| **n** | **5** | **10** | **25** | **50** | **100** |
| 15 | 0.967 | 1.703 | 2.632 | 3.321 | 4.005 |
| 20 | 0.919 | 1.625 | 2.517 | 3.179 | 3.836 |
| 25 | 0.888 | 1.575 | 2.444 | 3.088 | 3.729 |
| 30 | 0.866 | 1.541 | 2.393 | 3.026 | 3.653 |
| 35 | 0.851 | 1.516 | 2.354 | 2.979 | 3.598 |
| 40 | 0.838 | 1.495 | 2.326 | 2.943 | 3.554 |
| 45 | 0.829 | 1.478 | 2.303 | 2.913 | 3.520 |
| 50 | 0.820 | 1.466 | 2.283 | 2.889 | 3.491 |
| 75 | 0.792 | 1.423 | 2.220 | 2.812 | 3.400 |
| 100 | 0.779 | 1.401 | 2.187 | 2.770 | 3.349 |
| ∞ | 0.719 | 1.305 | 2.044 | 2.592 | 3.137 |

**Table Q3 (b): Coefficients for the IDF equations for Batu Pahat district ($30 \leq t \leq 1000$ min)**

| ARI (year) | a | b | c | d |
|---|---|---|---|---|
| 2 | 4.5023 | 0.6159 | -0.2289 | 0.0119 |
| 5 | 4.9886 | 0.3883 | -0.1769 | 0.0085 |
| 10 | 5.2470 | 0.2916 | -0.1575 | 0.0074 |
| 20 | 5.7407 | 0.0204 | -0.0979 | 0.0032 |
| 50 | 6.2276 | -0.2278 | -0.0474 | 0.00002 |
| 100 | 6.5443 | -0.3840 | -0.0135 | -0.0022 |

**Table Q3 (c): Values of adjustment factor, $F_D$ for West Coast and East Coast of Peninsular Malaysia**

| Duration | $^2P_{24}$ (mm) | | | | |
|---|---|---|---|---|---|
| | West Coast | | | | East Coast |
| (minute) | ≤ 100 | 120 | 150 | ≥ 180 | All |
| 5 | 2.08 | 1.85 | 1.62 | 1.40 | 1.39 |
| 10 | 1.28 | 1.13 | 0.99 | 0.86 | 1.03 |
| 15 | 0.80 | 0.72 | 0.62 | 0.54 | 0.74 |
| 20 | 0.47 | 0.42 | 0.36 | 0.32 | 0.48 |
| 30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**APPENDIX II**

**FINAL EXAMINATION**

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COURSE NAME : URBAN STORMWATER MANAGEMENT COURSE CODE : BFW 40503

**FIGURE**

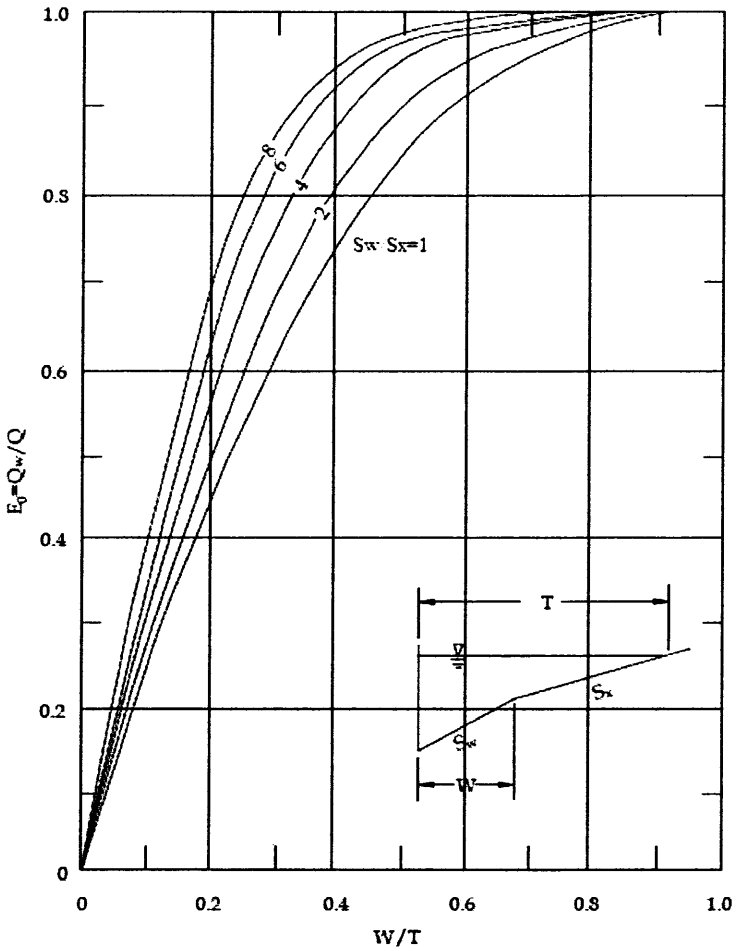


**Figure Q5 (b) / Rajah S5 (b)**

**APPENDIX III**

**FINAL EXAMINATION**

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 4 BFF
COURSE NAME : URBAN STORMWATER MANAGEMENT COURSE CODE : BFW 40503

## EQUATIONS

$$y = S_x T \qquad S_w = S_x + \frac{a}{W} \qquad T_s = T - W \qquad Q = \frac{k_n T^{8/3} S_x^{5/3} S_L^{1/2}}{2.64n}$$

$$Q = \frac{Q_s}{1 - E_o} \qquad S_x = \frac{S_{x1} S_{x2}}{S_{x1} + S_{x2}} \qquad A_{sb} = \frac{S_Q Z}{K(h_{avg} + Z)T_d} \qquad S_Q = nLWd_t$$

$${}^{R}P_d = P_{30} - F_D(P_{60} - P_{30}) \qquad Q_y = \frac{C.^y I_t.A}{360}$$

$$\ln({}^{R}I_t) = a + b(ln.t) + c(ln.t)^2 + d(ln.t)^3 \qquad I = \frac{P_T}{t_d} \qquad P_{T,M} = \frac{\sum P_j}{n}$$

$$P_T = P_{T,M} + Ks \qquad s = \sqrt{\frac{\sum(P_j - P_{TM})^2}{n-1}}$$