UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2015/2016 Academic Session

June 2016

EAH422 – Advanced Water Resources Engineering
[Kejuruteraan Sumber Air Lanjutan]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **TEN (10)** pages of printed material including **ONE (1)** appendix before you begin the examination.

[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***SEPULUH (10)*** *muka surat yang bercetak termasuk* ***SATU (1)*** *lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.

[***Arahan*** *: Kertas ini mengandungi* ***LIMA (5)*** *soalan. Jawab* ***EMPAT (4)*** *soalan.*]

All questions **MUST BE** answered on a new page.

[*Semua soalan* ***MESTILAH*** *dijawab pada muka surat baru.*]

In the event of any discrepancies, the English version shall be used.

[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.*]

1. [a] An area of 1000 ha in Sungai Petani, Kedah is designated for mixed development comprises of bungalow houses, semi- detached houses, school and shop terrace. Client specifies for sustainable drainage system to be incorporated in the development and shall be designed based on train of treatment for water quantity control and water quality control of stormwater. The development area is flat and the infiltration capacity is 4 mm/hr – 8 mm/hr. Discuss and propose the concept and framework for the sustainable drainage system. Selects appropriate devices to comply with quantity and quality control of the sustainable drainage system.

Kawasan seluas 1000 ha di Sungai Petani, Kedah telah dicadangkan untuk pembangunan bercampur yang terdiri dari rumah bungalow, rumah berkembar, sekolah dan kedai teres. Klien telah menggariskan untuk menerapkan sistem saliran mesra alam di dalam pembangunan tersebut dan rekabentuknya adalah berdasarkan kepada rawatan bersiri untuk kawalan kuantiti dan kawalan kualiti air ribut. Kawasan pembangunan adalah rata dan keupayaan penyusupan adalah 4 mm/jam – 8 mm/jam. Bincangkan dan cadangkan konsep dan rangka kerja sistem saliran mesra alam. Pilih perkakasan yang sesuai untuk memenuhi kawalan kuantiti dan kualiti sistem saliran mesra alam.

[10 marks/*markah*]

[b] A residential bungalow is proposed in Nibong Tebal, Penang. The area of the site is 960m^2, an above-ground storage Onsite Detention (OSD) will be provided in the lawn area at the front of the site. The storage will be excavated into the lawn and a brick retaining wall to be constructed along the front and side boundary of the site. The primary outlet will be an orifice and secondary outlet consists of broad crested weir slot in the retaining wall. The site condition before development was park lawn. The surface runoff flows into the OSD via perimeter drain to be designed for 5 year ARI from the site which consists as follows:-

Sebuah rumah kediaman bunglo akan dibangunkan di suatu kawasan seluas 960 m^2 di Nibong Tebal, Pulau Pinang. Kemudahan OSD di atas permukaan tanah dicadangkan untuk disediakan pada kawasan lanskap di hadapan rumah kediaman tersebut. Storan akan dibina dengan mengorek permukaan tanah dan tembok bata digunakan pada bahagian depan dan sisi storan tersebut. Struktur alur keluar terdiri dari orifis dan empang limpah puncak lebar. Keadaan tapak lot bunglo sebelum pembangunan adalah taman berumput. Air larian permukaan mengalir masuk ke dalam OSD melalui longkang perimeter direkabentuk dengan 5 tahun ARI dari kawasan lot bunglo seperti berikut:

Dwelling / *Kediaman*	= 350 m^2
Garage / *Garaj*	= 50 m^2
Driveway / *Laluan Masuk berturap*	= 50 m^2
Surface Paving and paths / *Laluan & Permukaan Berturap*	= 60 m^2
Lawns and Garden / *Lanskap & Taman*	= 450 m^2

To meet the requirement for water quantity control, determine the followings:
Untuk memenuhi kawalan kuantiti air ribut tentukan perkara berikut:

[i] peak discharge for predevelopment condition
puncak kadaralir pra-pembangunan

[ii] peak discharge for post development condition
puncak kadaralir pasca –pembangunan

[iii] permissible site discharge (PSD)
aliran keluar dari tapak yang dibenarkan (PSD)

[iv] volume of OSD required.
isipadu OSD yang diperlukan.

Note: Based the design of OSD by assuming t_c = 45 minutes, t_{cs} = 30 minutes, and t_d = 30 minute.

Nota: Anggapkan perkara berikut untuk rekabentuk OSD: t_c = 45 minit, t_{cs} = 30 minit, dan t_d = 30 minit.

[15 marks/*markah*]

2. [a] Please refer to **Table A1** (Appendix) and describe why an engineer that designs a water quality treatment facility requires the knowledge of local site condition and pollutants generated. Please provide a treatment example.

*Sila rujuk **Jadual A1** (Lampiran) dan terangkan mengapa seorang jurutera kejuruteraan air yang merekabentuk sebuah fasiliti rawatan kualiti air memerlukan pengetahuan tempatan tentang keadaan tapak dan bahan cemar yang dihasilkan. Sila berikan contoh rawatan.*

[10 marks/*markah*]

[b] Estimate the preliminary size of an infiltration trench for a proposed development in Nibong Tebal, Pulau Pinang with 1.5ha of commercial area and 0.5ha of sport field and park. Given that the value of infiltration rate, f = 3.0 mm/hr, maximum storage time, T_s = 24 hr, effective filling time, T_f = 2 hr and porosity of fill materials, n = 0.35. (Runoff coefficient for commercial and business centres = 0.95 and runoff coefficient for sport fields, park and agriculture = 0.40)

Anggarkan saiz awal parit penyusupan untuk pembangunan yang dicadangkan di Nibong Tebal, Pulau Pinang dengan 1.5 hektar kawasan komersial dan 0.5ha padang sukan dan taman. Diberi nilai kadar penyusupan, f = 3.0 mm/jam, masa penyimpanan maksimum, T_s = 24 jam, masa pengisian berkesan, T_f = 2 jam dan keliangan bahan isi, n = 0.35. (Pekali air larian untuk pusat komersil dan perniagaan = 0.95 dan pekali air larian untuk padang sukan, taman dan pertanian = 0.40)

[15 marks/*markah*]

3. [a] Water resource projects may provide several types of benefits. Discuss **FIVE (5)** benefits of water resources projecs.

*Projek sumber air boleh memberi beberapa kelebihan. Bincangkan **LIMA (5)** jenis kelebihan projek sumber air.*

[10 marks/*markah*]

[b] Determine **TWO (2)** benefits of a water resource project based on its value of goods and services produced and its activities derived from the project.

*Terangkan **DUA (2)** kelebihan projek sumber air berdasarkan kepada nilai barang dan perkhidmatan yang dihasilkan dengan aktiviti yang terhasil daripada projek.*

[5 marks/*markah*]

[c] Two project proposals were considered for a water project. Proposal A requires a large investment to meet demands for 50 years. The construction cost is RM40 Million and the Operational and Maintenance cost is approximately RM 160,000 for 50 years. The annual benefit expected is RM2.5 Million. The discount rate is given at 5%. The economic life and period of analysis is 50 years.

Proposal B requires investments in two phases to meet the same demand. The construction cost is RM25 Million for Phase 1 and RM30 Million for Phase 2. The Operational and Maintenance cost is approximately RM 100,000 for first 25 years and RM 220,000 for second 25 years. The annual benefit expected is RM2.5 Million. The discount rate is given at 5%. The economic life is 50 years at each phase and the period of analysis is 50 years.

Identify the most viable proposal for the water resource project.

Dua cadangan projek sedang dipertimbangkan untuk satu projek sumber air.

Cadangan A memerlukan pelaburan yang besar untuk memenuhi keperluan untuk 50 tahun. Kos pembinaan ialah RM40 Juta dan kos Operasi dan Senggaraan dianggar RM160,000 untuk 50 tahun. Kelebihan tahunan dijangka RM 2.5 Juta. Kadar diskaun diberi pada 5%. Hayat ekonomi dan kala analisis ialah 50 tahun.

Cadangan B memerlukan pelaburan dalam dua fasa untuk memenuhi keperluan yang sama. Kos pembinaan ialah RM25 Juta untuk Fasa 1 dan RM30 Juta untuk Fasa 2. Kos Operasi dan Senggaraan dianggar RM100,000 untuk 25 tahun pertama dan RM 220,000 untuk 25 tahun kedua. Kelebihan tahunan dijangka RM 2.5 Juta. Kadar diskaun diberi pada 5%. Hayat ekonomi adalah 50 tahun pada setiap fasa dan kala analisis ialah 50 tahun.

Kenalpasti cadangan yang boleh jaya untuk projek sumber air ini.

[10 marks/*markah*]

4. [a] Describe briefly the necessity and importance of irrigation work in our country

Terangkan dengan ringkas keperluan dan kepentingan sistem pengairan di negara ini.

[5 marks/*markah*]

[b] With the help of illustration, explain the differences between “free flooding” and “border flooding” techniques used in water distribution in the cultivation field.

Dengan menggunakan ilustrasi, terangkan perbezaan di antara teknik “pengaliran bebas” dan “pengaliran sempadan” yang digunakan untuk pengaliran air di tapak penanaman.

[8 marks/*markah*]

[c] Design a trapezoidal concrete lined channel to carry a discharge of 350 m^3/s. The natural slope of the channel is 1:6000. The side of the channel is taken as 1.5:1. The value of Manning's n for concrete lined channel is 0.013. Assume limiting depth of the flow in the channel as 4.0 m.

Rekabentuk sebuah saluran konkrit trapezoid untuk aliran 350 m^3/s. *Kecerunan saluran ialah 1:6000. Sisi saluran trapezoid mempunyai cerun 1.5:1. Nilai pemalar Manning n untuk saluran konkrit ialah 0.013. Anggap bahawa had kedalaman air dalam saluran ialah 4.0 m.*

[12 marks/*markah*]

5. A culvert is to be designed with the following data:

Sebuah pembetung akan dibina dengan ciri-ciri seperti berikut :

Design flood / *Rekabentuk luahan*	= 15 m^3/s
Manning's n / *Pekali kekasaran Manning*	= 0.024
Length / *Panjang*	= 30.0 m
Slope / *Cerun mendatar*	= 0.015
Entrance Loss Coefficient, K_e / *Pekali Kehilangan Tenaga, K_e*	= 0.9

The available pipe diameter are in multiples of 250 mm.

Saiz paip yang boleh digunakan adalah dengan gandaan garispusat 250 mm.

[a] Compute the proposed culvert size if the maximum permissible headwater level is 4 m above the invert, with the culvert discharging free at its outlet.

Kira saiz pembetung jika turus hadapan maksimum adalah 4 m dan jet bebas di luahan keluar.

[15 marks/*markah*]

[b] If the entrance loss coefficient is K_e 0.25, calculate the required culvert diameter for the conditions in [a]

Jika pekali kehilangan tenaga masukan, K_e adalah 0.25, kira saiz pembentung bagi keadaan [a]

[10 marks/*markah*]

APPENDIX / *LAMPIRAN*

Selected Equations for OSD Design

$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$
$PSD = \frac{a - \sqrt{a^2 - 4b}}{2}$
$a = \left(4\frac{Q_a}{t_c}\right)\left(0.333 t_c \frac{Q_p}{Qa} + 0.75 t_c + 0.25 t_{cs}\right)$
$b = 4 Q_a Q_p$
$SSR = 0.06 t_d (Q_d - c - d)$
$c = 0.875 PSD\left(1 - 0.459\frac{PSD}{Q_d}\right)$
$d = 0.214\frac{PSD^2}{Q_d}$

Fitting Constant for Design Rainfall Estimation (Jln. Mtg. Buloh Bgn. Serai Station)

λ	κ	θ	η
52.752	0.163	0.179	0.795

Runoff Coefficient

Landuse	Runoff Coefficient (C)	
	For Minor System (≤10 year ARI)	For Major System (> 10 year ARI)
Residential		
Bungalow	0.65	0.70
Semi-detached Bungalow	0.70	0.75
Link and Terrace House	0.80	0.90
Flat and Apartment	0.80	0.85
Condominium	0.75	0.80
Commercial and Business Centres	0.90	0.95
Industrial	0.90	0.95
Sport Fields, Park and Agriculture	0.30	0.40
Open Spaces		
Bare Soil (No Cover)	0.50	0.60
Grass Cover	0.40	0.50
Bush Cover	0.35	0.45
Forest Cover	0.30	0.40
Roads and Highways	0.95	0.95
Water Body (Pond)		
Detention Pond (with outlet)	0.95	0.95
Retention Pond (no outlet)	0.00	0.00

Table A1 / Jadual A1

Selection of BMPs for Various Pollutants

BMPs Type	Pollutant Removal Efficiency			Other factors			
	Gross Pollutants	TSS	Nutrient (TN & TP)	Maintenance	Land Required	Treatable Catchment Area	Cost
Infiltration	Low	High	High	Medium	High	Medium	Low
Bioretention	Low	High	High	Low	Medium	Medium	Medium
Swale	Low	Medium	Medium	Low	Low	Low	Low
GPT	High	Low	No	Medium	Medium	Medium	Medium
Water Quality Pond	Medium	Medium	Medium	Medium	High	High	High
Wetlands	Medium	High	High	High	Medium	High	High

Maximum allowable depth, $d_{max} = \frac{f_c T_s}{n}$

Design infiltration rate (f_d) $= 0.5\, f_c$

$$A_f = \frac{V_w}{n d_t + f_d T_f}$$

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