# KOLEJ UNIVERSITI TEKNOLOGI TUN HUSSEIN ONN

# PEPERIKSAAN AKHIR
## SEMESTER I
## SESI 2006/07

NAMA MATA PELAJARAN:    GEOLOGI KEJURUTERAAN

KOD MATA PELAJARAN  :    BFC 3013

KURSUS              :    3 BFC

TARIKH PEPERIKSAAN  :    NOVEMBER 2006

JANGKAMASA          :    3 JAM (BFC 3013)

ARAHAN              :    JAWAB **DUA (2)** SOALAN
                         DALAM **BAHAGIAN A** DAN
                         **SEMUA** SOALAN DALAM
                         **BAHAGIAN B**.

KERTAS SOALAN INI MENGANDUNGI **18** MUKA SURAT

## BAHAGIAN A (40 Markah)

S1 (a) Lukiskan simbol dan orientasi struktur geologi di atas kertas graf berdasarkan nilai yang diberikan dalam Jadual 1 di bawah.

Jadual 1

| Jenis Struktur | Arah Kemiringan | Sudut kemiringan |
|---|---|---|
| i.   Kekar | 200° | 40° |
| ii.  Foliasi | 340° | 80° |
| iii. Lapisan | 30° | 10° |
| iv.  Sinklin (Arah tunjaman 45°) | | |
| v.   Antiklin (Arah tunjaman 245°) | | |

(15 markah)

b) Terangkan dengan ringkas data-data yang diperolehi daripada teknik penggerudian teras batuan.

(5 markah)

S2 (a) Berikan takrifan ketakselanjaran?

(2 markah )

(b) Senaraikan ciri-ciri bahan terluluhawa gred 4, 5 dan 6?

(8 markah )

(c) Secara ringkas, nyatakan kaitan siri Bowen dengan kadar luluhawa.

(5 markah)

(d) Secara ringkas, terangkan perbezaan sifat dan asal mula di antara tanah baki dan kolovium.

(5 markah )

S3 (a) Dengan menggunakan lakaran yang sesuai, terangkan dengan jelas sudut kemiringan dan arah jurus.

(4 markah )

(b) Senaraikan mod kegagalan cerun batuan dan nyatakan faktor yang menghasilkan kegagalan tersebut berdasarkan ketakselanjaran.

(8 markah )

(c)     Senaraikan sifat fizikal ketakselanjaran yang perlu di cerap di
        lapangan.

(8 markah)

**BAHAGIAN B (60 Markah)**

S4      Di dalam plan jajaran cadangan lebuhraya melalui arah timurlaut –
        baratdaya (45°-230°), cerun batuan akan dipotong secara kotak
        mengikut jajaran lebuhraya. Sudut potongan cerun adalah 60°. Rajah
        **S4** menunjukkan jajaran lebuhraya tersebut. Satu pemetaan struktur
        geologi telah dilakukan di sepanjang cadangan cerun batuan tersebut.
        Berikut adalah keputusan pemetaan orientasi ketakselanjaran (format;
        arah kemiringan / sudut kemiringan) seperti dalam Jadual **2**.

Jadual **2**

| 090/40 | 095/45 | 160/70 | 310/80 |
|--------|--------|--------|--------|
| 312/83 | 305/82 | 155/75 | 078/43 |
| 093/37 | 150/75 | 151/71 | 084/39 |
| 300/70 | 305/75 | 180/15 | 091/31 |

a)      Plotkan orientasi bagi setiap ketakselanjaran secara plot kutub
        dengan menggunakan jaringan stereo sama luas menggunakan
        Rajah **S4(a)** dan kertas surih.

(4 markah)

b)      Anggarkan dan plotkan kedudukan purata kutub untuk setiap
        tiga set ketakselanjaran tersebut.

(3 markah)

c)      Plotkan bulatan besar untuk setiap purata kutub bagi setiap set
        di atas jaringan sama luas.

(6 markah)

d)      Berdasarkan jawapan soalan **S4(c)** dan sudut geseran
        permukaan ketakselanjaran adalah 30°, lukiskan cerun batuan
        yang miring ke arah tenggara, 135° (A) dan baratlaut 315° (B).

(6 markah)

e) Analisa set ketakselanjaran dan jenis mod kegagalan yang berpotensi untuk gagal bagi kedua-dua arah potongan cerun arah kemiringan tenggara, 135° (A) dan baratlaut 315° (B).

(6 markah)

f) Beri cadangan sudut cerun batuan tercuram bagi kedua-dua cerun tersebut tanpa menyebabkan kemungkinan berlakunya kegagalan cerun dengan mengambil kira faktor orientasi ketakselanjaran dan sudut geseran ketakselanjaran sahaja.

(4 markah)

g) Kajian terhadap set ketakselanjaran mendapati semua ketakselanjaran mempunyai sudut geseran 30° dan jeleketan 100 kPa. Sudut potongan cerun seperti dinyatakan dalam soalan di atas, manakala bahagian atas cerun mempunyai arah kemiringan dan sudut kemiringan 130°/10° untuk cerun A dan 310°/10° untuk cerun B.

Daripada kajian di lapangan dan di makmal, maklumat berikut diperolehi:

(i)   Unit berat batuan ($\gamma$) = 25 kN/m$^3$
(ii)   Unit berat air ($\gamma_w$) = 9.81 kN/m$^3$
(iii)   Ketinggian kegagalan baji (H) = 100 meter

Berdasarkan Rajah **S4(b)** atau **S4(c),** kirakan faktor keselamatan cerun (FK) untuk keadaan bukaan ketakselanjaran yang dipenuhi air.

(20 markah)

(h) Projek lebuhraya tersebut masih didalam peringkat perancangan, dimana cerun batuan tersebut masih belum dipotong. Apakah cadangan anda bagi mendapatkan maklumat struktur geologi diperingkat perancangan ini.

(4 markah)

S5      Cerun batuan granit akan dipotong dalam arah kemiringan dan sudut kemiringan 195°/70°. Terdapat tiga satah utama ketakselanjaran iaitu J1: 190°/45°, J2: 040°/40° dan J3: 330°/80°. Berikan potensi mod kegagalan cerun batuan tersebut berdasarkan analisa potensi kegagalan cerun menggunakan jaringan sama luas yang boleh di perolehi dari Rajah **S2(a)**. Klien mengarahkan rekabentuk cerun batuan tersebut stabil dengan faktor keselamatan 1.5.

Berdasarkan kajian di lapangan dan di makmal, maklumat berikut diperolehi:

     i)      Unit berat batuan, $(\gamma)$, = 25 kN/m$^3$
     ii)     Unit berat air. $(\gamma_w)$, = 9.81 kN/m$^3$
     iii)    Ketinggian cerun batuan, (H), = 30 meter
     iv)    Kedalaman rekahan tegangan, (Z), = 2 meter
     v)     Daya jeleketan satah ketakselanjaran = 100 kPa
     vi)    Sudut geseran permukaan ketakselanjaran = 30°

Model cerun batuan adalah seperti dalam Rajah **S4(b)** dalam keadaan bukaan ketakselanjaran dipenuhi air.

Apakah sudut kemiringan cerun batuan yang perlu dibina dengan mengambil kira keadaan yang paling kritikal dimana keseluruhan daripada rekahan diisi air $(Z_w)$.
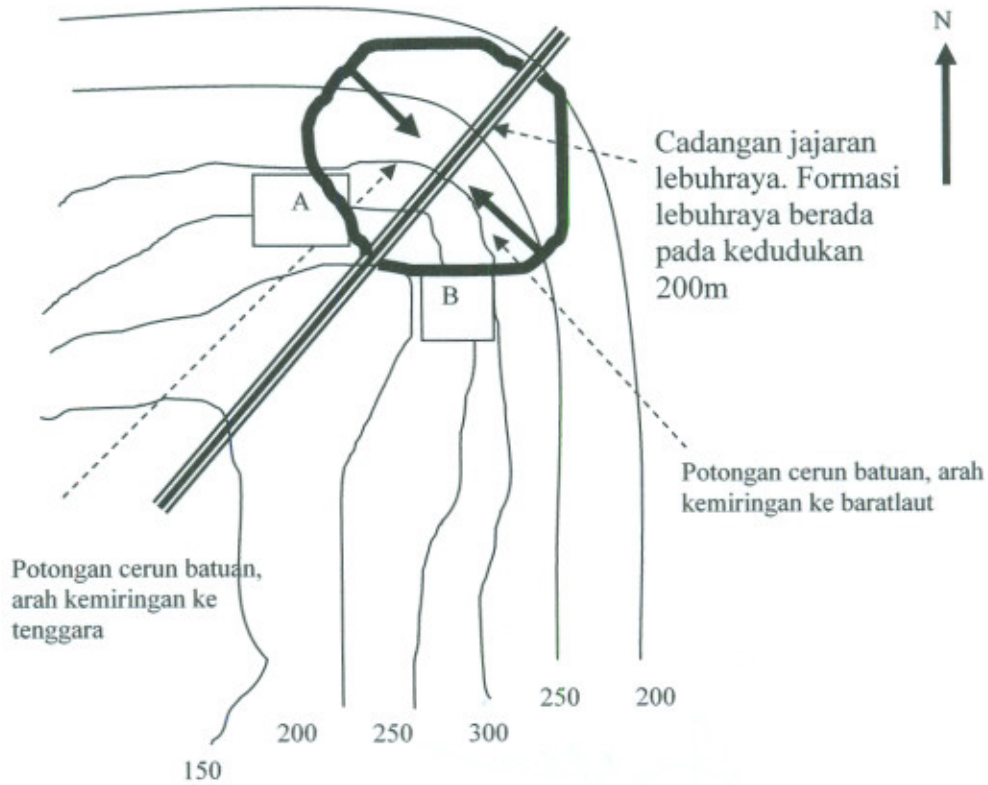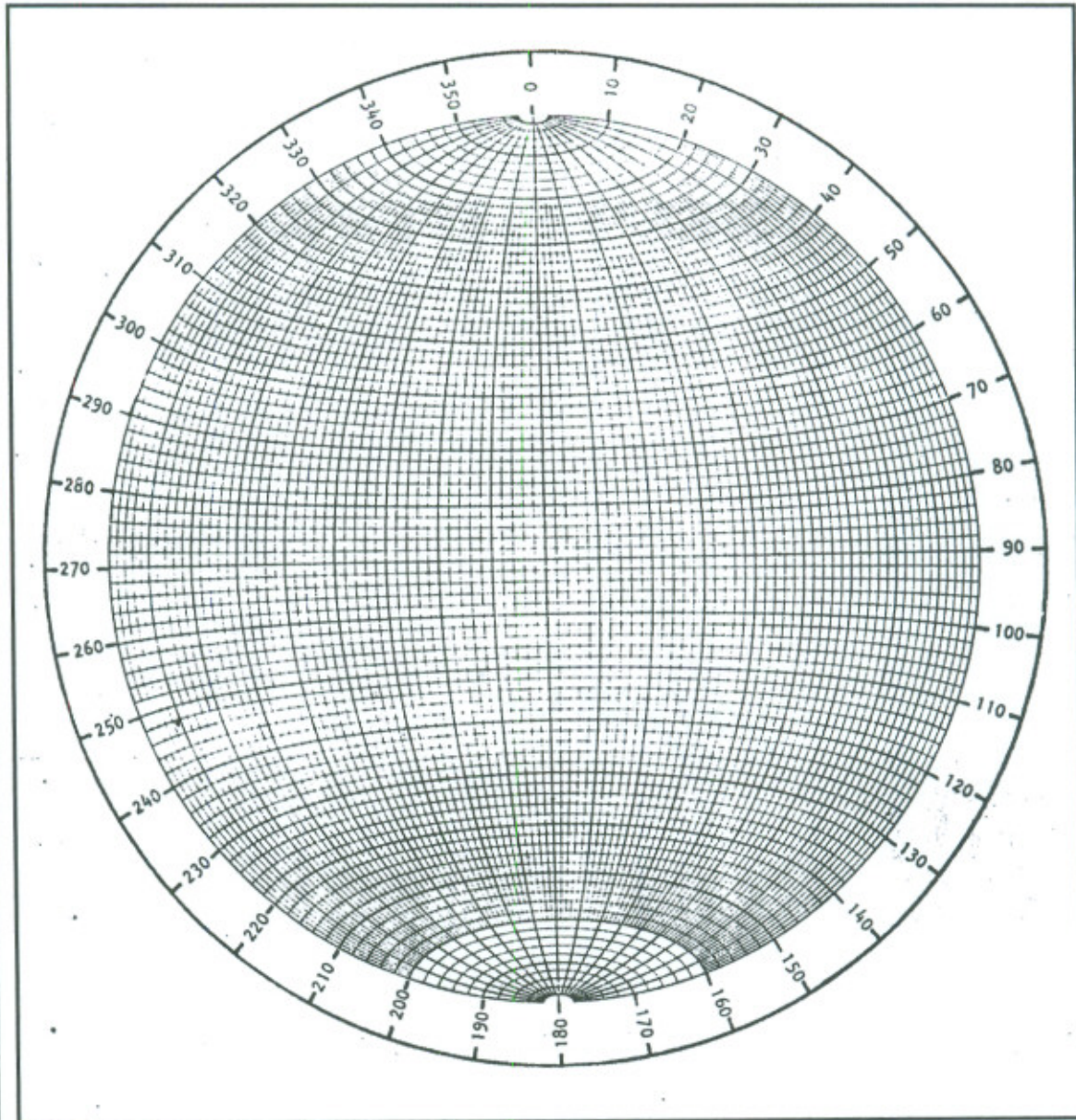
(7 markah)

PEPERIKSAAN AKHIR

SEMESTER/SESI:   SEMESTER I/2006/2007          KURSUS     :   3 BFC / 3 BKA
MATAPELAJARAN:  GEOLOGI KEJURUTERAAN    KOD MATA PELAJARAN:  BFC 3013/ BKA 3522



N

Cadangan jajaran
lebuhraya. Formasi
lebuhraya berada
pada kedudukan
200m

Potongan cerun batuan, arah
kemiringan ke baratlaut

Potongan cerun batuan,
arah kemiringan ke
tenggara

250     200

200     250     300

150

Rajah S4 : Cadangan jajaran lebuhraya dan cerun batuan berbentuk kotak sebelah A dan
sebelah B.

(tidak mengikut skala)

# PEPERIKSAAN AKHIR

Rajah **S4(a)**

# PEPERIKSAAN AKHIR

SEMESTER/SESI : SEMESTER 1/2006/2007   KURSUS : 3 BFC / 3 BKA
MATAPELAJARAN: GEOLOGI KEJURUTERAAN   KOD    : BFC 3013 / BKA 3522
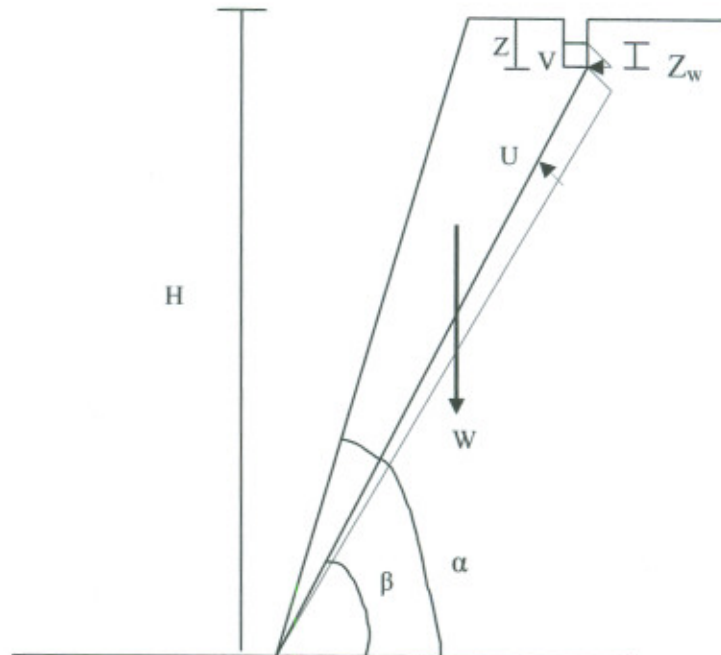


**Diberi:**

$$F = \frac{cA + (W\kos\beta - U - V\sin\beta)\tan\phi}{W\sin\beta + V\kos\beta}$$

A = luas satah kegagalan          $\phi$ = sudut geseran
c  = jeleketan                    U = tekanan air menegak
W  = berat blok kegagalan         V = tekanan air mendatar
$\beta$ = sudut satah kegagalan   $\alpha$ = sudut cerun
H = Ketinggian cerun              Z = Rekahan tegangan
A = (H-Z).kosek $\beta$
W = ½ $\gamma$. H² [(1-(Z/H)²)kot $\beta$ – kot $\alpha$]
U = ½ $\gamma_w$.$Z_w$ .(H-Z).kosek $\beta$
V = ½ $\gamma_w$.$Z_w$

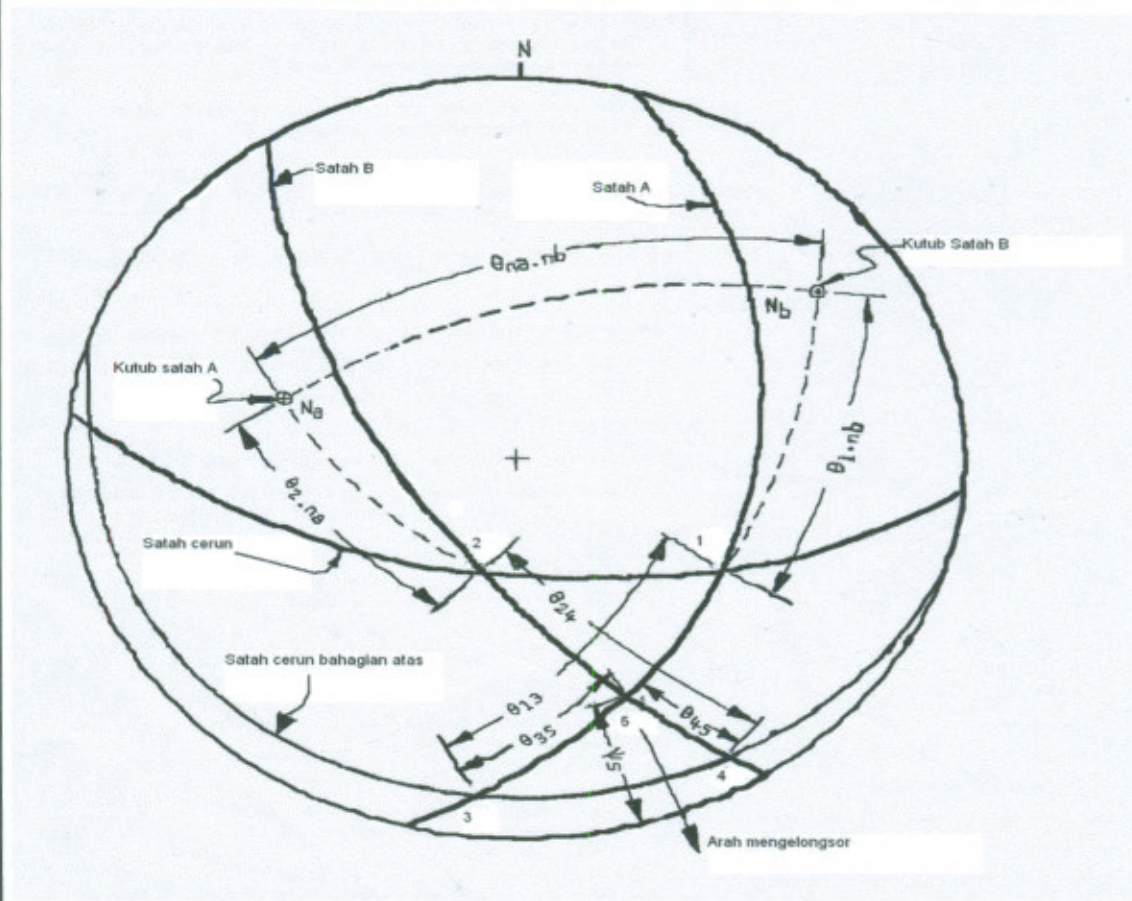$$kosek\beta = \frac{1}{\sin\beta} \qquad sek\beta = \frac{1}{kos\beta} \qquad kot\beta = \frac{1}{\tan\beta}$$

Rajah **S4(b)**

## PEPERIKSAAN AKHIR

SEMESTER/SESI   :   SEMESTER1/2006/2007    KURSUS    :  3BFC / 3BKA
MATAPELAJARAN:   GEOLOGI KEJURUTERAAN  KOD     :  BFC 3013 / BKA 3522



**Diberi:** $Fos = \dfrac{3}{\gamma H}(C_a.X + C_b.Y) + (A - \dfrac{\gamma_\omega}{2\gamma}.X)Tan\phi_a + (B - \dfrac{\gamma_\omega}{2\gamma}.Y)Tan\phi_b$

$C_a$ = jelekitan                           $\phi_b$ = sudut geseran

H = Ketinggian baji                  $\psi_a$ = sudut kemiringan ketakselanjaran a

$\psi_b$ = sudut kemiringan ketakselanjaran b      $\psi_5$ = sudut kemiringan persilangan baji

X, Y, A, B adalah faktor yang dipengaruhi oleh geometri baji:

$$X = \dfrac{Sin\theta_{24}}{Sin\theta_{45}Kos\theta_{2.na}} \qquad Y = \dfrac{Sin\theta_{13}}{Sin\theta_{35}Kos\theta_{1.nb}} \qquad A = \dfrac{Kos\psi_a - Kos\psi_b Kos\theta_{na.nb}}{Sin\psi_5.Sin^2\theta_{na.nb}}$$

$$B = \dfrac{Kos\psi_b - Kos\psi_a Kos\theta_{na.nb}}{Sin\psi_5.Sin^2\theta_{na.nb}}$$

Rajah **S4(c)**

# KOLEJ UNIVERSITI TEKNOLOGI TUN HUSSEIN ONN

# FINAL EXAMINATION
## SEMESTER I
## SESSION 2006/07

| | | |
|---|---|---|
| SUBJECT NAME | : | ENGINEERING GEOLOGY |
| SUBJECT CODE | : | BFC 3013 |
| COURSE | : | 3 BFC |
| DATE OF EXAMINATION | : | NOVEMBER 2006 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWERS **TWO (2)** QUESTIONS IN **PART A** AND **ALL** QUESTIONS IN **PART B** |

## PART A (40 Marks)

**Q1** (a) Draw the geological structures symbol based on orientation given in graph paper;

| Types of structure | Dip direction | Dip angle |
|---|---|---|
| i. Joint | 200° | 40° |
| ii. Foliation | 340° | 80° |
| iii. Bedding | 30° | 10° |
| iv. Syncline (plunge direction to 45°) | | |
| v. Anticline (plunge direction to 245°) | | |

(15 marks)

b) Explain briefly the types of data derived from drilling techniques of rock coring.

(5 marks)

**Q2** (a) What is the meaning of discontinuity?

(2 marks)

(b) List the characteristics of weathered materials of Grade 4, 5 and 6?

(8 Marks)

(c) Explain briefly the relationship between Bowen Series with rate of weathering.

(5 marks)

(d) Explain briefly the differences in characteristics and its origin between the residual soils and colluviums.

(5 marks)

**Q3** (a) Using relevant figures, explain in detail the angle of dip and direction of strike.

(4 marks)

(b) List the rock failure modes and state the factors that cause the slope failure related to discontinuity.

(8 marks)

(c)   List the physical characteristics of discontinuities need to be observed in the fieldwork.

(8 marks)

**PART B (60 Marks)**

**Q4**      In the proposal of highway alignment with direction northeast-southwest (45°-230°), box cut rock slope will be excavated that follows the highway alignment. The face slopes angle is 60°. Figure **Q4** shows the highway alignment. A structural geology mapping for the proposed highway has been performed along the proposed cut slope. The following are the results for orientation of the discontinuities (format- dip direction / dip angle) as shown in Table **2**.

Table 2

| | | | |
|---|---|---|---|
| 090/40 | 095/45 | 160/70 | 310/80 |
| 312/83 | 305/82 | 155/75 | 078/43 |
| 093/37 | 150/75 | 151/71 | 084/39 |
| 300/70 | 305/75 | 180/15 | 091/31 |

(a)   Plot the orientation of each discontinuity as a pole on a stereo net using the equal area shown in Figure **Q4(a)** and tracing paper.

(4 marks)

(b)   Estimate and plot the position of the mean pole of each of the three sets of discontinuities.

(3 marks)

(c)   Plot the great circles of the mean pole of each set on the equal area net.

(6 marks)

(d)   Based on question **Q4(c)** and if friction angle of discontinuity planes are 30°, plot the rock slopes dipping to southeast, 135° (A) and to northwest, 315° (B).

(6 marks)

(e)     Analyze the most likely mode of failures create by the discontinuity sets for rock slope dipping to southeast (A) and to northwest (B)

(6 marks)

(f)     Give a suggestion the steepest possible slope angle for those two slopes A and B assuming that only the orientation of discontinuities and friction angle of the surfaces have to be considered.

(4 marks)

(g)     The study of joint sets indicates that all joint have friction angle of 30° and cohesion 100kPa. Cut slope angles are given in above questions. While the upper slope, dip direction over dip angle is 130°/10° for slope A and 310°/10° for slope B.

From the site study and laboratory works, the following information have been gathered:
(i)      Rock unit weight $(\gamma) = 25$ kN/m$^3$
(ii)     Water unit weight, $(\gamma_w) = 9.81$ kN/m$^3$
(iii)    Height of wedge (H) = 100 meter

By using Figure **Q4(b)** or **Q4(c)**, calculate safety factor of the slope with condition discontinuities aperture is fully filled by water.

(20 marks)

(h)     The proposed highway is in the planning stage, yet the slope to be cut. What is your suggestion to obtain the structural geology data in planning stage.

(4 marks)

**S5**    (a)    Rock slope of granite will cut at dip direction over dip angle 195°/70°. There are three main discontinuities, namely J1: 190°/45°, J2: 040°/40° and J3: 330°/80°. By using equal area stereo net as shown in figure **Q4(a),** find the potential of rock failure mode. The client instructs the designer to get the stable slope angle with safety factor of 1.5.

From the site study and laboratory works, the following information have been gathered:
  a. Rock unit weight ($\gamma$) = 25 kN/m$^3$
  b. Water unit weight, ($\gamma_w$) = 9.81 kN/m$^3$
  c. Height of rock slope (H) = 30 m
  d. Depth of tensional cracks (Z) = 2 m
  e. Cohesion of discontinuity (c) = 100 kPa
  f. Friction angle of discontinuity ($\phi$) = 30°

Model of rock slope as per Figure **Q4(b)** where the tensional crack is fully filled with water.

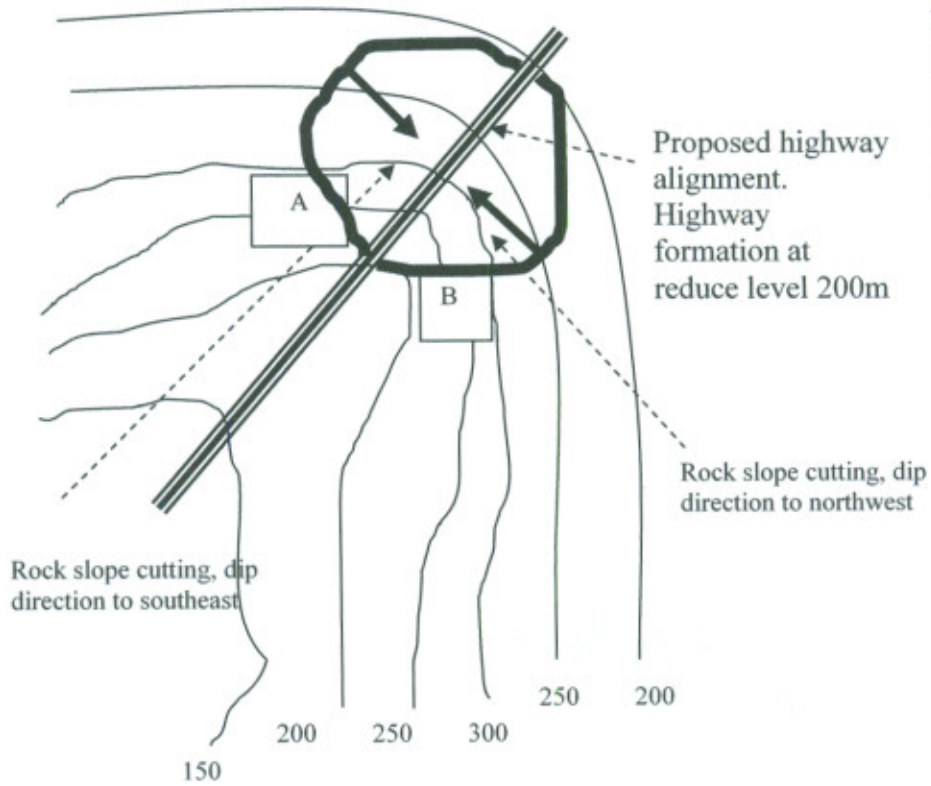Find the rock slope angle which consider critical condition the cracks are fully filled with water ($Z_w$)

(7 marks)

N

Proposed highway
alignment.
Highway
formation at
reduce level 200m

Rock slope cutting, dip
direction to northwest

Rock slope cutting, dip
direction to southeast

250     200

200     250     300

150

Figure Q4 : Proposed road alignment and the box cut of rock slope A side and B side.

(not to scale)

# FINAL EXAMINATION

SEMESTER/SESSION   :   1/2006/2007        COURSE   :   3BFC / 3 BKA
SUBJECT:   ENGINEERING GEOLOGY        SUBJECT CODE  :   BFC 3013 / BKA 3522
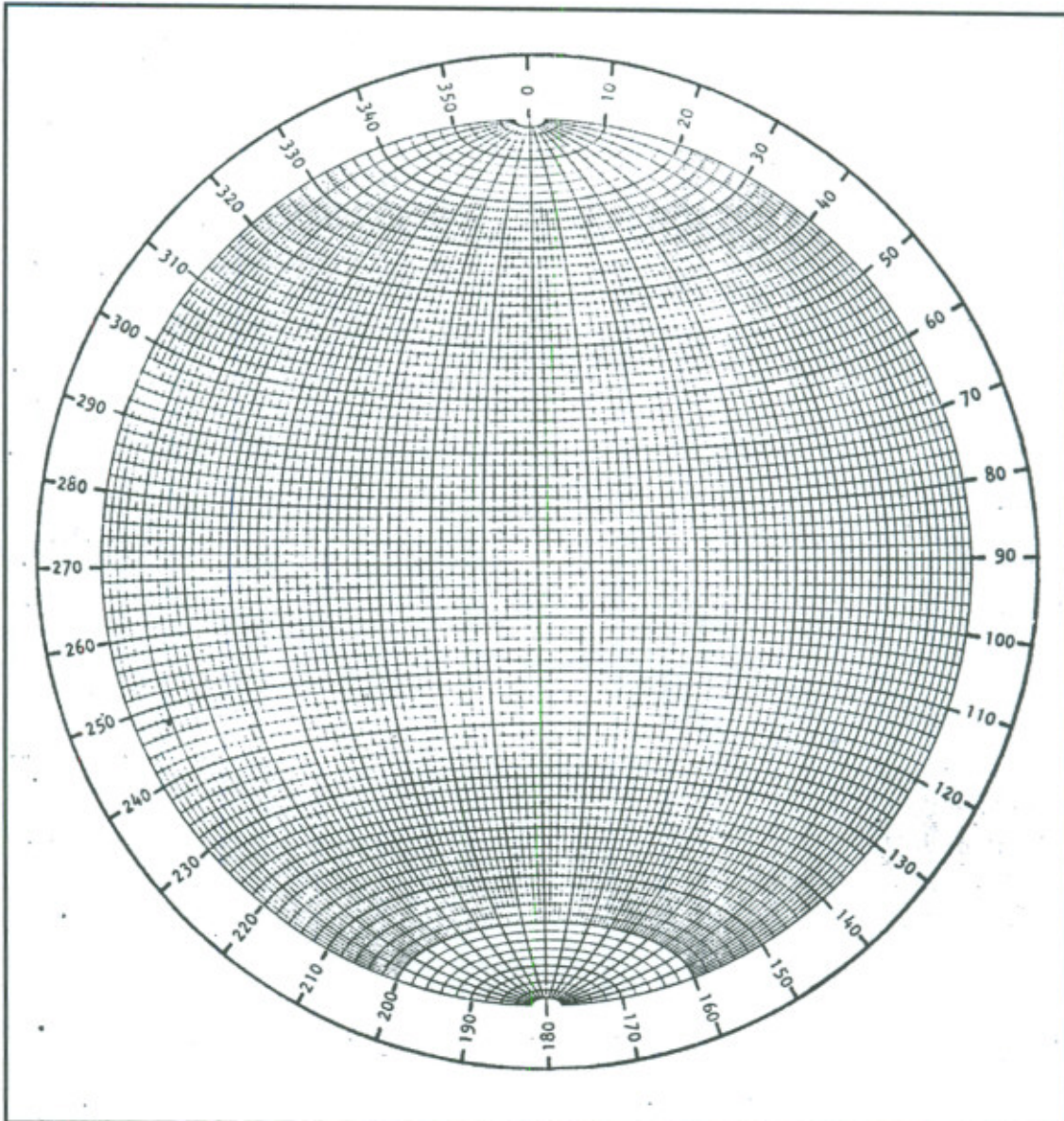


Figure **Q4(a)**

# FINAL EXAMINATION
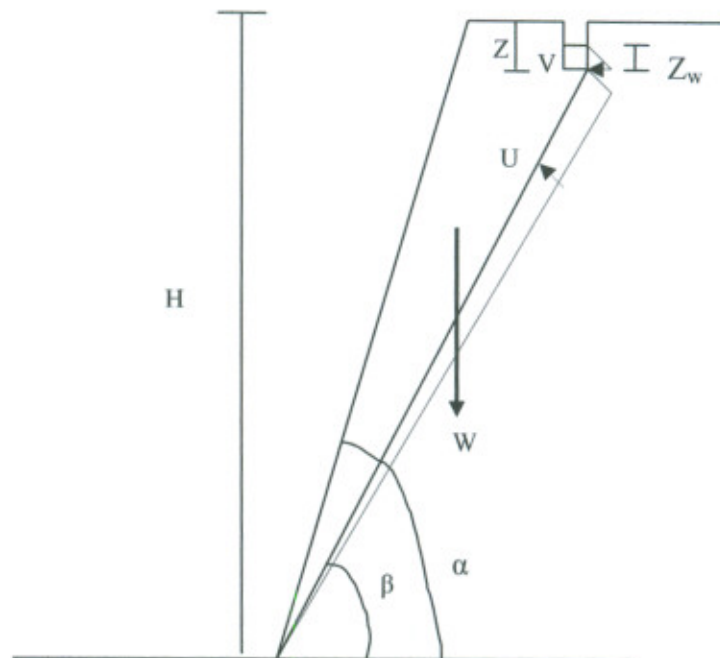
**Given:**

$$F = \frac{cA + (W\cos\beta - U - V\sin\beta)\tan\phi}{W\sin\beta + V\cos\beta}$$

A = failure plane area          $\phi$ = friction angle
c = cohesion                    U = vertical water pressure
W = weight of failure block     V = horizontal water pressure
$\beta$ = failure plane angle   $\alpha$ = slope angle
H = Height of slope             Z = Tensional cracks

A = (H-Z).cosec $\beta$

W = ½ $\gamma$. H² [(1-(Z/H) ²)cot $\beta$ – cot $\alpha$]

U = ½ $\gamma_w$.$Z_w$ .(H-Z).cosec $\beta$

V = ½ $\gamma_w$.$Z_w$

$$\cos ec\,\beta = \frac{1}{\sin\beta} \qquad \sec\beta = \frac{1}{\cos\beta} \qquad \cot\beta = \frac{1}{\tan\beta}$$

Figure **Q4(b)**

# FINAL EXAMINATION
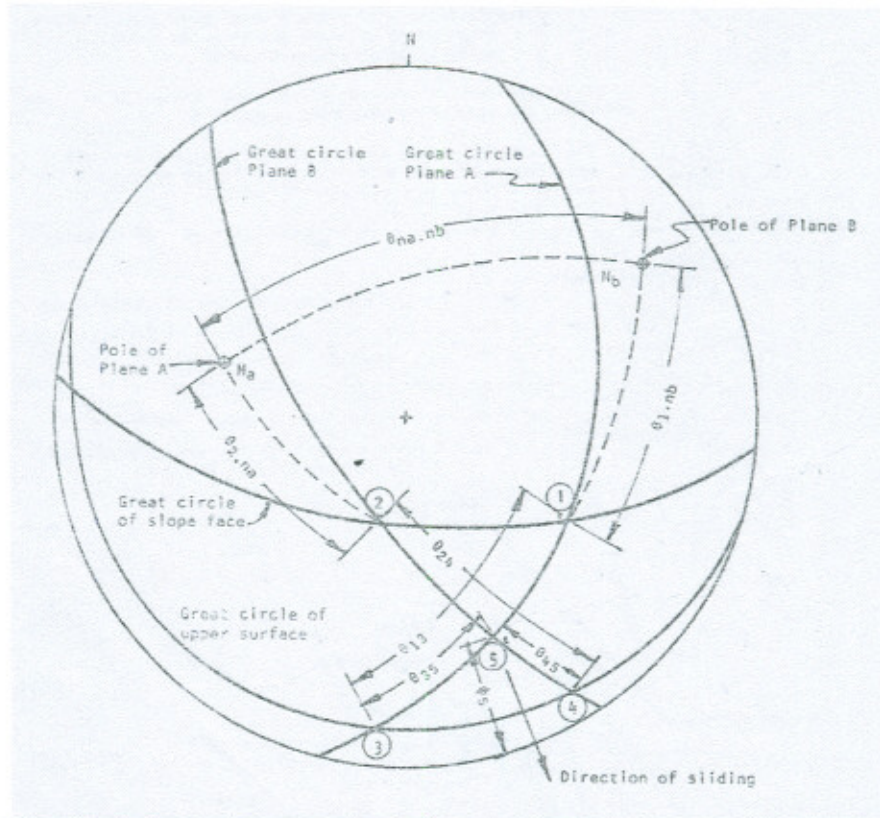
**Given:**

$$Fos = \frac{3}{\gamma H}(C_a.X + C_b.Y) + (A - \frac{\gamma_a}{2\gamma}.X)Tan\phi_a + (B - \frac{\gamma_a}{2\gamma}.Y)Tan\phi_b$$

$C_a$ = Cohesion           $\phi_b$ = Friction angle
$H$ = height of wedge       $\psi_a$ = dip angle for plane a
$\psi_b$ = dip angle for plane b     $\psi_5$ = dip angle for wedge intersection
X, Y, A, B is factor which depend upon the geometry of wedge

$$X = \frac{Sin\theta_{24}}{Sin\theta_{45}Cos\theta_{2.na}} \qquad Y = \frac{Sin\theta_{13}}{Sin\theta_{35}Cos\theta_{1.nb}} \qquad A = \frac{Cos\psi_a - Cos\psi_b Cos\theta_{na.nb}}{Sin\psi_5.Sin^2\theta_{na.nb}}$$

$$B = \frac{Cos\psi_b - Cos\psi_a cos\theta_{na.nb}}{Sin\psi_5.Sin^2\theta_{na.nb}}$$

Figure **Q4(c)**