

## slide - Introduction to OpenGL

OpenGL - 06 ৰাখ API Provide কৰে।

stitch X librae কোড়ো ৱা  
প্ৰোগ্ৰাম কৰে।

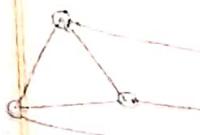
Related libraries : glut.h

gl.h — object transformation, scaling, etc কৰে।  
+ tool

glu.h — camera positioning, rotation handle কৰে।

glut.h — advance.

[except glutiniting file] তোৱে একটা প্ৰোগ্ৰাম  
glut.h — window create কৰে। কাৰণ gl.h library  
windowse / mouse, keyboard create কৰে না।  
অপোসিটরিলাৰি দৰিদ্ৰ।



Object Space:

Object এৰ বস্তু কোনো স্থানে। height, width,  
depth কো ত বিয়ে আৰি নন। য বাবে কো কো কো  
বিশেষ কো কো।

World space: object এ অধীন আৰি কো কো কো

Eye space/in viewer কো কো কো কো কো কো কো

location কো কো কো কো কো কো কো কো কো

location কো কো কো কো কো কো কো কো কো

location কো কো কো কো কো কো কো কো কো

## Modelling & Viewing - TAN125 27/3/1

ଫିଲ୍ ମୁଦ୍ରଣ :

- ① color / translate / rotate

$$g^1 \frac{1}{(1)} \frac{1}{(2)}$$

- ⑪ 3f / 3d

3 → float are stranded  
f → float ~~float~~ ~~stranded~~  
f ~~float~~ ~~stranded~~

• ക്ലേർ object തന്നെ,

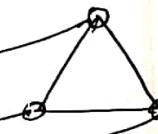
glBegin(GL\_TRIANGLES)

# IRIS vertex pt define

gl vertex 3f/3d ( $\leftarrow$ )

glvertex 3f / 3d ( )  
glvertex 3f / 3d ( )

gl vertex 3f/3d ( ) ←



glend ( ) ; glen ( ) ;

एवं तेज़ vertex आए (10E), But primitive type 5  
line आणि वैकल्पिक ग्राफ़ sequentially starts E1 line असता।  
प्रथम नंबर पर फॉर, then ...

Polygon एवं त्रिकोणीय भूमि को उपरी सतह पर भरने का प्रकार → color

यह तरीके polygon को माझेहां खाले बाबे fill-up करा

GL-TRIANGLES-STRIP →  $(v_0, v_1, v_2), (v_1, v_2, v_3)$

GL-TRIANGLES-FAN → common vertex  $(v_0)$  के लिये

Program :

ALU-T-RGB → color

- DEPTH → को नाम्यां द्वारा प्रदान कराया गया / depth buffer

idle fn → animation घटना का चलना

parameters घटना करायी जाने वाली fn

object coordinate → (Eg. notes) लिखा

Shape → (1. s

radius → इसका अर्थ यह है कि आप इसकी विस्तृति को बढ़ावा देते हैं।

जब वे विशिष्ट world space (P) के नामांगन करते हैं तो वे position

object space के object के coordinate के रूप में लिखते हैं ( $0, 0, 0$ )

(उस विशिष्ट world space के नामांगन के रूप में लिखते हैं) जो विशिष्ट विशिष्ट विशिष्ट विशिष्ट

→ अपनी विशिष्ट विशिष्ट विशिष्ट विशिष्ट

stack size  
 Model View matrix after push  
 stack size  
 glPushMatrix() → original state  
 glPopMatrix() → original state  
 position (x, y, z) → relative position (change).  
 stack size

glMatrixMode() → project matrix or matrix mode  
 projection matrix → stack size → 2 (0)

Frustum → હાથ કરી ફુલમાર |  
 Human → view system config. naturally?

Normal (raster રૂપ) → rectangle shape.

View window — ફ્લાન્ડ |

glViewport( ) → screen એ કોણ ડેટા દ્વારા નકલ  
 (x, y, width, height) or define કરો!

(0, 0, 0) → aspect ratio is forced to work 1:1

- Window & viewpoint એ aspect ratios same રીતે નથી, અને circle, ellipse એલ્લો એલ્લો.

gluLookAt(  $\frac{pt1}{pt1}, pt2, pt3$  ).

pt] → ଗେହା ଆମ୍ବ

pt 2 — " ନମ୍ରତ ଶାହ

pt 3 → !! മന്ത്രാലയം

when  $(0, 0, d)$  is on negative

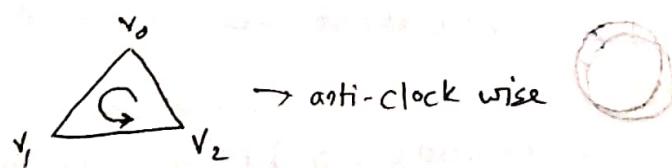
2-axis ଏ ଗଣତ ଦିଲ୍ଲୀ ।

glutSwapBuffers(); →

## internal processing — back phase

display — front phase

glut Main Loop ( ) → indefinite time to execute after



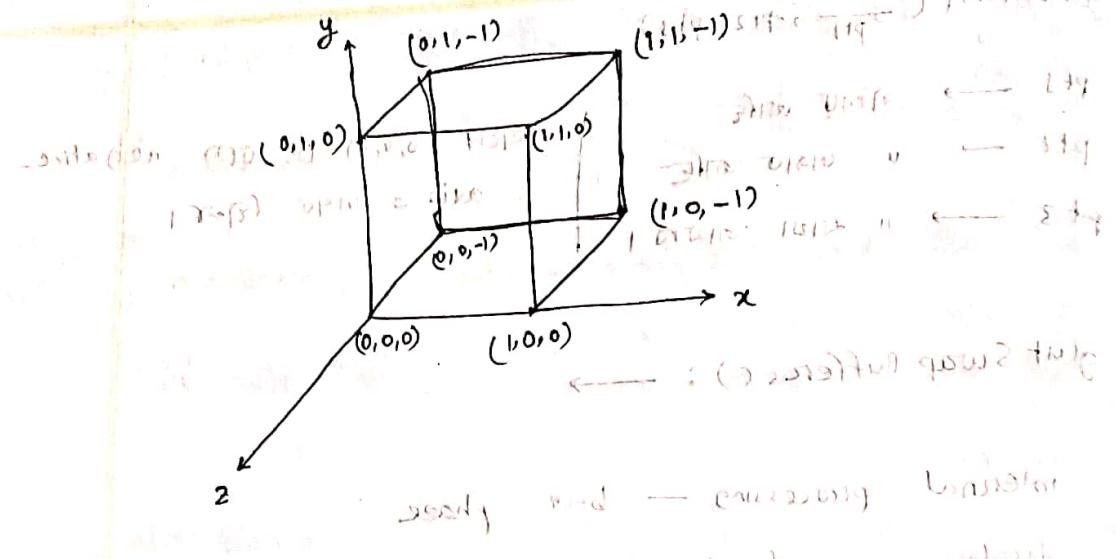
‘ersten ffa ମା ପ୍ରାଚୀନ୍ୟ back phase ଯାଏଇ ଯାଏ ଦେଖିବ ଆଶା ନାହାନ୍ ।

卷之三

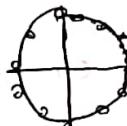
Carlsbad

23. 10. 300. 1000. 2000. 3000.

ab 17 abgewandert



circle →  
from physics 1D  $x = r \cos \theta$   $y = r \sin \theta$



- Rotate about all 3 axis
- Translate
- Rotate
- Scale
- Zoom-in, zoom out.
- Report (on lab)

### Assignment:

- Open GL -  $f^h$  -(40)
- GLU -(16)
- GLUT -(10)
- $f^h$ , parameters,  
example.  $f^h$  description

11 September, 2019

## Graphics - 02

• ଅନ୍ତର node କି ଓହିତ କାମରୁ ପାଇଁ array ଫର୍ମାଇ ।

• triangle-vertices[] = {

-1, 0, 0 → ଫର୍ମି ପଟ ସାହିଁ node .

(କାମରୁ ପାଇଁ ଏହିତିକି କିମ୍ବା କିମ୍ବା)

ନେଟୀଙ୍କ ବିଶେଷ

{ Data type }

→ float → ନିମ୍ନଲିଖିତ

glVertexPointer ( 3 , GL\_FLOAT , 0 , triangle-vertices );

↑

↑

3D

stride

(ତ୍ରିକ କାମରୁ କାମରୁ)

[ଅଧିକ କାମରୁ ନା]

• vertexpointer enable କାମରୁ କାମରୁ glEnableClientState (GL\_VERTEX\_

ARRAY);

• କାମରୁ (ଥିଏ) vertex disable କାମରୁ

(କାମରୁ କାମରୁ) glDisableClientState (GL\_VERTEX\_

ARRAY);

↑

II ୩ triangle

pyramid :

- vertices କୁଣ୍ଡା କାମରୁ array ("କାମରୁ ; 5 କି point ୨୦ )

- face କୁଣ୍ଡା 3 କି କାମରୁ pt face, କିମ୍ବା ଯୁଗମାଳା କାମରୁ

କାମରୁ (କାମରୁ)

- color fixed କାମରୁ (କାମରୁ କାମରୁ)

• glutInitDisplayMode

• glutCreateWindow

• glutOneFitCall ( user define fn )  
• glutArrayEnable ( color to vertex or not )

• eyePosition ( camera position )

• gluLookAt ( a, b, c, 0, 0, -2, 0, 1, 0 )

    ↓  
    eye position → eye position  
    direction → direction

    ( eye position, direction )

$$\begin{bmatrix} 1 & 0 & 0 & dx \\ 0 & 1 & 0 & dy \\ 0 & 0 & 1 & dz \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

• Object → glMatrixMode ( GL\_MODELVIEW )

• glMultMatrix

• Assignment:

① Implement roll, pitch, and yaw in gluLookAt in your own project.

## Lighting —

ଆମେ କିମ୍ବା କିମ୍ବା ଏହି ପଦରେ ଆମର କିମ୍ବା



① Light ରେ position -

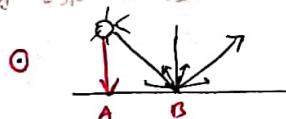
(Light Location) → a mailing ② Light ରେ color - (Light)

position (10, 20, 30, 1) →  
position (10, 20, 30, 0) → direction

position  
(10, 20, 30)

① ଅମ୍ବାର ହିୟବ କବଳାମ solid surface. ଉଚନେ reflect କାହାର ।

ଏହାର ଗୁଡ଼ିକ ରହିଥିଲା ତାହାର ନିର୍ଦ୍ଦିଷ୍ଟ ନିର୍ଦ୍ଦିଷ୍ଟ  
specular reflection.



→ ଶାନ୍ତିକ reflect କାହାର diffuse reflection.

ଏହାର ଗୁଡ଼ିକ ରହିଥିଲା ତାହାର ନିର୍ଦ୍ଦିଷ୍ଟ ନିର୍ଦ୍ଦିଷ୍ଟ

② Materialistic property → surface କବଳିବାରେ ଖାଲ ନିର୍ଦ୍ଦିଷ୍ଟ

angle ରେ light ରେ ଅଧିକ କିମ୍ବା କିମ୍ବା reflect କାହାର କାହାର ଗୁଡ଼ିକ material

ଯର ଚାରୀ ରେ କୋଣ ଦେବାରେଇଲା (reflectivity = r)

$(0.5, 0, 0) \rightarrow$  red ରେ 50% absorb / 50% reflect କାହାର

ଏହାର ଗୁଡ଼ିକ ରହିଥିଲା ତାହାର ନିର୍ଦ୍ଦିଷ୍ଟ ନିର୍ଦ୍ଦିଷ୍ଟ

ସାଫଲ୍ଲାଇଟିକ ରେ କିମ୍ବା କିମ୍ବା color କାହାର କାହାର

ଏହାର ଗୁଡ଼ିକ ରହିଥିଲା ତାହାର ନିର୍ଦ୍ଦିଷ୍ଟ ନିର୍ଦ୍ଦିଷ୍ଟ

ଏହାର ଗୁଡ଼ିକ ରହିଥିଲା ତାହାର ନିର୍ଦ୍ଦିଷ୍ଟ

Shineiness → surface

Shineiness → extra light dependent on surface

extra light करने extra light (1%) नहीं करते  
scattered light हैं 1%

- यदि position = (10, 20, 30, 0) then position  $\rightarrow$  (directional light)

जल्दी सिर्फ जैसा करें। यहाँ पर्याप्त और angle  
extra light करते surface का असर। calc easy है।

- यदि (10, 20, 30, 1) (point source) के जैसे calc करें,

- Light का diffuse color & specular color होते हैं।  
जैसे real हैं, इनकी property जैसी हिमें देखें।



- Ambient: मान एवं उपरान्त जैसा करें surface पर light

reflect करे जैसे जल्दी energy का अधिकार कर। उन्होंने जैसा करना जैसा करना sun/...

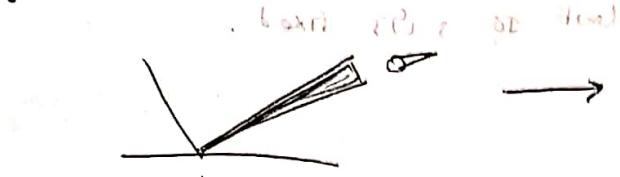
- ambient light का अधिकार जैसा करे surface पर

mat-ambient: ambient light का अधिकार जैसा करे ambient reflectivity  
जैसा करना material का असर।

• यहाँ use करें, जैसे object का असर जैसा करना

Property का जैसा करना, जैसा करना materialistic

- glEnable(GL\_LIGHTING) → lighting 터치(ঠাই) কোড নেওয়ালাইট এবং [BaseLine].
- এখন স্লিপার্স লাইট তার জন্য → নেওয়ালাইট কোড | light enable  
জন্মনাম :  
(light enable ->)
- surface normal সুপরে normalize কোড এবং glEnable(GL\_NORMALIZE)
- glLightfv(GL\_LIGHT0, GL\_AMBIENT, light\_ambient) →  
0 নং light এর ambient কোড color কোড দিবে।
- শিল্পে (LIGHT0) সারি কোড দিবে।
- specular reflectivity viewer এর → position পরিপন্থ নেওয়ালাইট এবং  
Diffuse এর নাম।  
1 টির সময়ের অন্তরে পরিপন্থ নেওয়া।
- 



এবং অন্যান্য কোড এর point  
এর জন্মনাম specular effect

মাটি খেতে আছে এবং একটি sphere  
figure, 1 কেবল মাটির পৃষ্ঠা

বেশ জোড়া হচ্ছে এবং একটি পৃষ্ঠা এবং একটি পৃষ্ঠা  
বেশ জোড়া হচ্ছে এবং একটি পৃষ্ঠা এবং একটি পৃষ্ঠা  
বেশ জোড়া হচ্ছে এবং একটি পৃষ্ঠা এবং একটি পৃষ্ঠা  
বেশ জোড়া হচ্ছে এবং একটি পৃষ্ঠা এবং একটি পৃষ্ঠা

shininess এর কোড।

Shininess এর কোড = narrow কোড।

→ ↓  
পৃষ্ঠা একটি surface  
পৃষ্ঠা type

(cone of)

• front face में रियर वर्फे  $\rightarrow$  Along  $\theta$   
glMaterialfv(GL\_FRONT, GL\_AMBIENT, {0.2, 0.2, 0.2});

$$\sum I_L \cos \theta \times P$$

[ $I_L$  - Incident light]

→ glViewport(0, 0, sceneWidth, sceneHeight) → set object centre  
→ 4x4 transformation matrix → एक बात को पैरामिटर वाला बनाएं।

प्रॉजेक्शन कैमरा सेटिंग (camera setup)

पैरामिटर चेंज करने के लिए पैरामिटर बदलें।

पैरामिटर बदलने के लिए पैरामिटर बदलें।

last यह 3x3 fixed.

पैरामिटर बदलने के लिए पैरामिटर बदलें।

### Assignment:

→ Roll, pitch, yaw

→ Create a home env. place your object on the table and apply single source and multiple source light and material properties on it. Light should be dynamic.  
Home env. should consist one table and walls atleast.

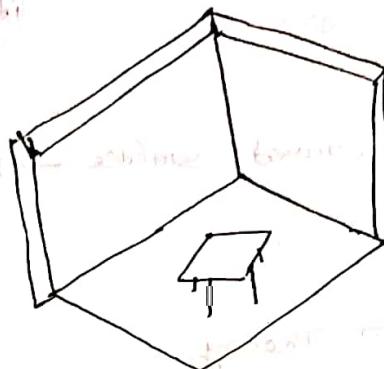
Table এর মৌলিক গান্ধি আর্থ

Step 1: Sphere আবর্তে।

Step 2: Sphere আবর্তে।



glut দিয়ে  
শর্মণে গো



Step 3: Sphere আবর্তে।

Step 4: Sphere আবর্তে।

Step 5: Sphere আবর্তে।

তিনি পার্টি দিক ঘো  
পুরুষ হিসেবে দিতে। Table ৭৩  
ছেট।

\* There should be no glColor function.

(সেকেন্ড কোড দেখো) এবং কোড বাইট

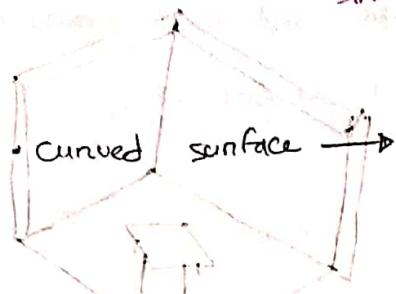
কোড দেখো।

এই কোড দেখো।

16.10.2019

Graphics - 04

### slide - Texture Mapping



parametric texture then  
screen coordinate = 1

of Theory.



OpenGL →

• Vertex wise color gradient computation color |

• texture mapping area, range, mapping 2D |

• rendering area to area map 2D |

■ glBindTexture (GL\_TEXTURE\_2D, textureName)

↑  
gl 2D texture      ↑  
name of texture

যেসোর multiple img o texture রিভুল কিংবা এভি,

• glTexImage2D (GL\_TEXTURE\_2D, level, components, width,  
height, border, format, type,

level → Bit mapping এর নম্ব লাগে

components → normally o সাধারণ | GL\_RGB সাধারণ o BGR |

- glTexParametersi (GL\_TEXTURE\_2D, GL\_TEXTURE\_MAG\_FILTER, GL\_LINEAR)

Default values of these parameters are:

- GL\_TEXTURE\_2D: GL\_REPEAT
- GL\_TEXTURE\_MAG\_FILTER: GL\_LINEAR
- GL\_TEXTURE\_MIN\_FILTER: GL\_LINEAR\_MIPMAP\_NEAREST

GL\_REPEAT, GL\_LINEAR  
GL\_CLAMP or GL\_CLAMP\_TO\_EDGE  
GL\_NEAREST

ARB texture parameter value 3 for 1  
and GL\_CLAMP for 2

- glTexGen (GLenum coord, GLenum pname, GLint param);

if 4D 3D texture  $\rightarrow$  (s, t, r, q)



some subtexels  $\rightarrow$



Ass:

Apply texture mapping on your project. Apply zooming effect changing the aperture of the window. Next week full project submission.

table  $\rightarrow$  wood texture

wall  $\rightarrow$  brick texture

floor  $\rightarrow$  floor texture

background  $\rightarrow$  background texture

light  $\rightarrow$  light texture

camera  $\rightarrow$  camera texture

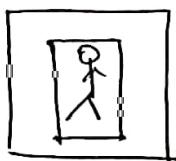
mouse  $\rightarrow$  mouse texture

key  $\rightarrow$  key texture

mouse button  $\rightarrow$  mouse button texture

zooming සංයුත් පාලි → model transform  
 object හෝ → model transform  
 මෙහේ මැස → viewing transform

1st camera සංයුත් window යොමු ඇත් මෙය picture  
 2nd sensor සංයුත් මැස මෙහේ මැස  
 3rd window යොමු ඇත් මෙය scene නෑදා ඇත්ති  
 far සංයුත් sensor මැටි ලැබුණු ගේ නෑදා scene මැටි  
 near object මැටි zoom මැටි



(far) → (near) → window සංයුත්



→ window සංයුත්

→ window සංයුත්

length of a step in camera coordinate system

- View transform motion → roll, pitch, yaw, 200m, circular motion

- Model transformation → zoom, panning, rotation

- Lighting, texture, two viewpoint (without texture, with texture)

panning → Translation (came/slide) ...  $\rightarrow$  70)

viewport →  $\rightarrow$  70

texture  $\rightarrow$  was 70

4 December, 2019

Graphics - 05

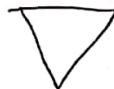
fractal construction

•  $\rightarrow$  70

Snowflake pattern → (42701)

→ 70

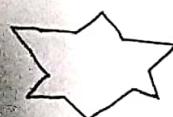
Koch snowflake → Snowflake  $\rightarrow$  geometry.



→ Depth = 0

front edge 1

→ 70 edge 1



→ D = 1

$\angle$  = 120

→ Depth  $\rightarrow$  complex 2D, 3D

→ 70 spike

→ 70

അംഗൾ

12

edge

ഒരു ഫോറ്മാറ്റിനു പുറത്തെ അംഗൾ

- ഡാമ്പർ Recursion ഫീഡ് കാര്യം

Code :

resize fn.

$\rightarrow$  മാൻ സ്ലിഫ്റ്റ്രേഷൻ യോഗ്യമാക്കുന്നത്

സൗജന്യ

glutReshape (leftx, rightx, lefty, righty, width, height);

left bottom

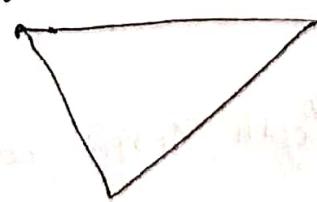
right top

glued variables

• Line  $\overline{PQ}$  through (0,0) മുകളിലെ വൈദിക വിവരങ്ങൾ

Oldx, Oldy  $\rightarrow$  initial ക്രമ പഠന ചെയ്യാം

(Oldx, Oldy)



Depth എന്ന് അപേക്ഷി ആണോ!

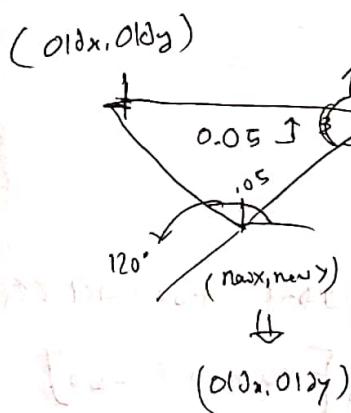
Koch curve (depth) {

• color buffer - will create a gradient,

• line iteration

drawKoch(0.0, 0.05, depth);  
degree length → iteration

↳ formula (cell) (first edge triangle)



degree (or radian)  
→ convert to cor,  
 $(\text{newx}, \text{newy}) \Rightarrow (\text{oldx}, \text{oldy})$ ,  
(update)

Oriented 250

$x \rightarrow 250^\circ$

around 90°,

drawKoch (float dir, len, iter) {

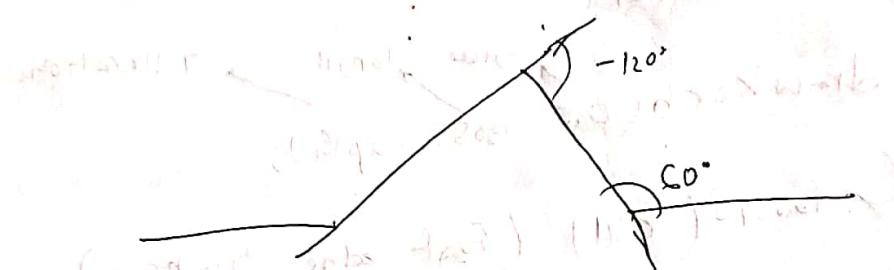
$$\text{dir rad} = 0.17453 \times \text{dir.}$$

$$\text{newx} = \text{oldx} + \text{len} \times \cos(\text{dir rad}) \\ + \text{len} \times \sin(\text{dir rad})$$

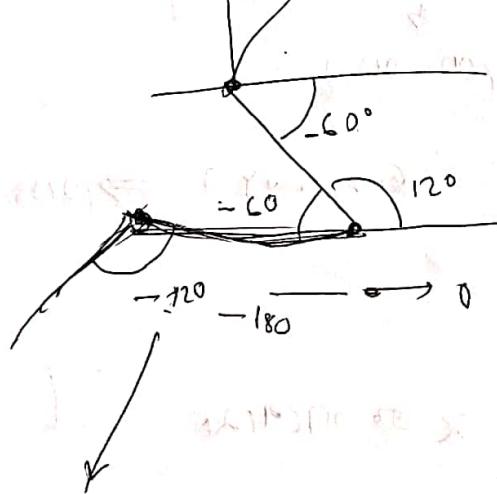
98351



3



ஒத்து விடும் போது



$$\left[ \begin{aligned} & \text{குறிச் } +60 \text{ யாசு கடிச} \\ & E 120 + 60 = -60 \end{aligned} \right]$$

$\Rightarrow -180$  யாசுமா।

$-120$  நான் கிழ்

எல்ல  $-180$  ஏ

60 (யாசு)

என் மூன் எல்  $-60$ ,

எல்  $-120$  (எல்ல)

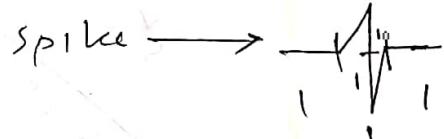
(letter, letters) → ଅନ୍ତର୍ମାଣ କିମ୍ବା ?

• ପରିମାଣ କରିବାର ଲାଭ ହେଉଥିଲା spike କାରଣରେ ।

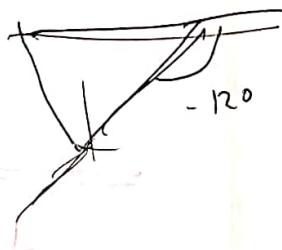
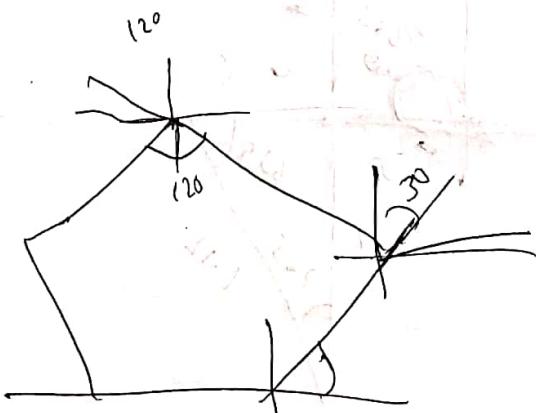
• ଯେତେ ଶାଖା ଦେଇ କିମ୍ବା କିମ୍ବା shape କିମ୍ବା

ହେବା ।

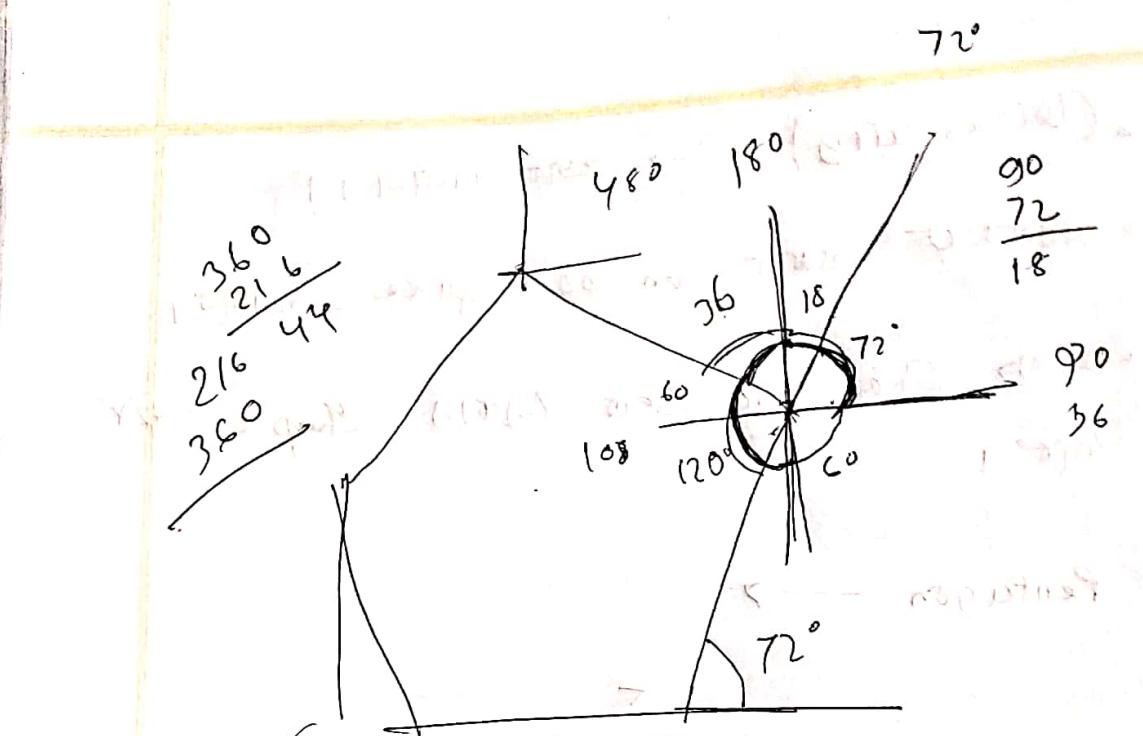
Pentagon →



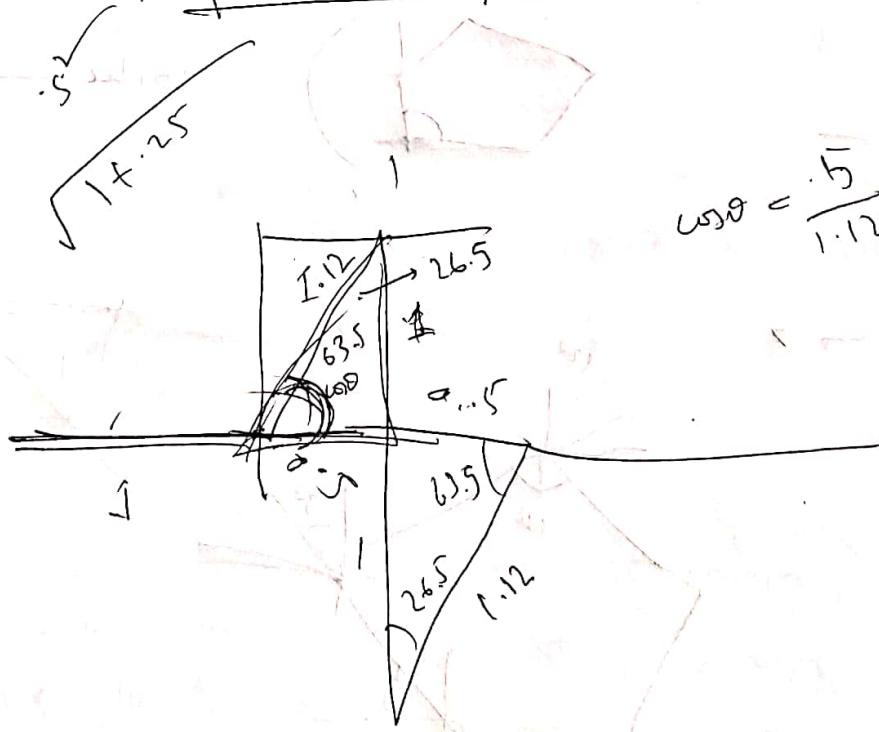
Ip →



54



$$\cos \theta = \frac{.5}{1.12}$$



Assignment → +