

Faculty of Engineering and Technology

Electrical and Computer Engineering Department

Electromagnetics 1 (ENEE 3408)

**Assignment #2 Surface and Volume Integrals**

**Prepared by**

 **Yazan Yousef – 1170249**

**Section No. 1**

Instructor

Dr. Ashraf Al-Rimawi

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**Question**: The surfaces, , , , and define a closed surface.

Find:

1. The enclosed volume
2. The area of the closed surface *S*.
3. Write a MATLAB program to verify your answer.



Figure 1: The surface of the question

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1. To find the volume *v* of a closed surface we first find out *dv,* the volume element. In spherical coordinates, *dv* is given by**.** Once we get the expression of *dv*, we integrate *dv* over the entire volume.
2. The area of the closed surface is given by

We need to find, , , , . Then we need to integrate them over their boundary. It is obvious that .

Now we have,

So,

Calculating the integrals will give

1. The following MATLAB code verify the previous answers:

V = 0; %initialize volume of the closed surface to 0

S1 = 0; %initialize the area of S1 to 0

S2 = 0; %initialize the area of S2 to 0

S3 = 0; %initialize the area of S3 to 0

S4 = 0; %initialize the area of S4 to 0

S5 = 0; %initialize the area of S5 to 0

r = 0; %initialize r to the its lower boundary

theta = pi/4; %initialize theta to the its lower boundary

phi = pi/4; %initialize phi to the its lower boundary

Number\_of\_r\_Steps = 1000; %initialize the r discretization

Number\_of\_theta\_Steps = 1000; %initialize the theta discretization

Number\_of\_phi\_Steps = 1000; %initialize the phi discretization

dr = (2-0)/Number\_of\_r\_Steps; %The r increment

dtheta = (pi/2-pi/4)/Number\_of\_theta\_Steps; %The theta increment

dphi = (pi/2-pi/4)/Number\_of\_phi\_Steps; %The phi increment

%%the following routine calculates the volume of the enclosed surface

for k = 1: Number\_of\_phi\_Steps

 for j = 1: Number\_of\_theta\_Steps

 for i = 1: Number\_of\_r\_Steps

 V = V + r^2 \* sin(theta) \* dphi \* dr \* dtheta;

 end

 r = r + dr; %The first loop increment the r

 end

 r = 0;

 theta = theta + dtheta; %The second loop increment theta

end

Volume = V %the volume of the shape

%%To calculate the circular area

r = 2 ; theta = pi/4;

for j = 1: Number\_of\_theta\_Steps

 for i = 1: Number\_of\_phi\_Steps

 S1 = S1 + r^2 \* sin(theta) \* dphi \* dtheta;

 end

 theta = theta + dtheta;

end

%To calculate the left and right areas which have the same area

r = 0; %re-enter the initial values

for k = 1: Number\_of\_theta\_Steps

 for j = 1: Number\_of\_r\_Steps

 S2 = S2 + r\* dtheta \* dr;

 end

 r = r + dr;

end

if dphi ~= 0

 S3 = S2;

end

%%To calculate the lower area on the xy plane

r = 0; theta = pi/2; % re-enter the the initial values

for k = 1: Number\_of\_r\_Steps

 for i = 1: Number\_of\_phi\_Steps

 S4 = S4 + r \* sin(theta) \* dphi \* dr;

 end

 r = r + dr;

end

%%To calculate the upper area

r = 0; theta = pi/4; % re-enter the the initial values

for k = 1: Number\_of\_r\_Steps

 for i = 1: Number\_of\_phi\_Steps

 S5 = S5 + r \* sin(theta) \* dphi \* dr;

 end

 r = r + dr;

end

Surface\_area = S1+S4+S3+S4+S5 %the area of the enclosed surface

Answers:

Volume = 1.4785

Surface\_area = 8.0384