Sets, logic, combinatorics, simultaneous equations, matrices algebra, number, probability

Sets:

Power set of set A is a set of all subsets of A.

Cardinality of power set is 2n, where n is cardinality of A.

Union of sets A and B is a set, which includes all elements of A and all elements of B.

Intersection of sets A and B is a set, which includes all elements, which are both in A and B.

Cardinality of union of A and B is equal to cardinality of A + cardinality of B - cardinality of intersection of A and B.

A – B means all elements which are in A but NOT in B.

Sets operations are similar to logical operations:

NOT for sets is NOT for logic,

intersection for sets is AND for logic,

union for sets is OR for logic.

Logic:

Compound propositions include 2 or more propositions.

Tautology: True (for any truth values of their variables)

Contradiction: False (for any truth values of their variables)

P OR NOT P is a tautology.

P AND NOT P is a contradiction.

IFF means if and only if:

If you study hard (H), then you will be rich (R) H 🡪 R and if you are rich (R), then you must have studied hard (H) R 🡪 H.

This means that if and only if you study hard (H), then you will be rich (R) H🡨🡪R

The truth table for IFF is:

|  |  |  |
| --- | --- | --- |
| H | R | H if and only if R |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

H 🡪 R

Converse is: R 🡪 H

Inverse is: NOT H 🡪 NOT R

Contrapositive is: NOT R 🡪 NOT H

Question:

Compare truth tables of implication, conversion, inversion, contraposition.

Predicate is logical function.

Example x > 5, this true if x > 5 and false otherwise.

We proved by induction for predicate P(n).

If I am in Jakarta then I am on Java, if I am on Java then I am in Indonesia, therefore, if I am in Jakarta then I am in Indonesia.

Indonesia includes Java, Java includes Jakarta.

Argument

All humans are mammals.

I am a human; therefore, I am a mammal.

Incorrect argument:

All humans are mammals.

I am a mammal; therefore, I am a human.

Combinatorics:

If order matters, then we use permutations:

Question:

Calculate number of permutations L out of T: P(T,L).

I have million (106) options for my 6-digit pin-number.

Question:

How many options are for L decimal digits password?

Simultaneous linear equations

x and y are unknows variables, we must find they from solving simultaneous equations.

a, b, c, d, e, f are known numbers.

ax+by = c

dx+ey = f

Substitution:

Elimination:

eax + eby = ec

bdx + bey = bf

eax – bdx = ec – bf

(ea– bd)x= ec – bf

Cramer rule says that

Here

= ae - bd

= ce - bf

= af - cd

det is determinant.

Finding inverse matrix

If you have matrix then the inverse matrix is

If you have matrix then the inverse matrix is

This is the same as given by Cramer Rule.

Product of matrix and its inverse matrix gives multiplicative identity matrix

If you have inverse matrix, then you can multiply left and right sides of your simultaneous equations by inverse matrix and get the answer.

Torque t is expressed through moments of inertia I and angular acceleration a.

m = 1, 2, 3.

We use Cramer Rule

en.wikipedia.org/wiki/Cramer%27s\_rule

= I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) –

I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) +

I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

D must not be zero.

Question:

Calculate angular acceleration for given tensor of inertia and torque.

I11 = s mod 11

I12 = s mod 12

I13 = s mod 13

I21 = s mod 21

I22 = s mod 22

I23 = s mod 23

I31 = s mod 31

I32 = s mod 32

I33 = s mod 33

t1 = s mod 10

t2 = s mod 20

t3 = s mod 30

torque(1) = s Mod 10

torque(2) = s Mod 20

torque(3) = s Mod 30

Dim a(3), I(3, 3), torque(3)

s = 99107088

torque(1) = s Mod 10

torque(2) = s Mod 20

torque(3) = s Mod 30

I(1, 1) = s Mod 11

I(1, 2) = s Mod 12

I(1, 3) = s Mod 13

I(2, 1) = s Mod 21

I(2, 2) = s Mod 22

I(2, 3) = s Mod 23

I(3, 1) = s Mod 31

I(3, 2) = s Mod 32

I(3, 3) = s Mod 33

determinant = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

If determinant = 0 Then GoTo 1

'MsgBox determinant

I(1, 1) = torque(1)

I(2, 1) = torque(2)

I(3, 1) = torque(3)

determinant1 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(1) = determinant1 / determinant

MsgBox a(1)

I(1, 1) = s Mod 11

I(2, 1) = s Mod 21

I(3, 1) = s Mod 31

I(1, 2) = torque(1)

I(2, 2) = torque(2)

I(3, 2) = torque(3)

determinant2 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(2) = determinant2 / determinant

MsgBox a(2)

I(1, 2) = s Mod 12

I(2, 2) = s Mod 22

I(3, 2) = s Mod 32

I(1, 3) = torque(1)

I(2, 3) = torque(2)

I(3, 3) = torque(3)

determinant3 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(3) = determinant3 / determinant

MsgBox a(3)

I(1, 3) = s Mod 13

I(2, 3) = s Mod 23

I(3, 3) = s Mod 33

' Checking correctness of the solution:

For c = 1 To 3

'MsgBox torque(c)

Next c

For c = 1 To 3

torque(c) = 0

For cc = 1 To 3

torque(c) = torque(c) + I(c, cc) \* a(cc)

Next cc

'MsgBox torque(c)

Next c

GoTo 2

1 determiniantIsZero = 0

MsgBox "Determinant = 0, no solutions"

2 ThereAreSolusions = 2

Checking for 2

Dim a(2), I(2, 2), torque(2)

s = 99107088

torque(1) = s Mod 10

torque(2) = s Mod 20

I(1, 1) = s Mod 11

I(1, 2) = s Mod 12

I(2, 1) = s Mod 21

I(2, 2) = s Mod 22

determinant = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

If determinant = 0 Then GoTo 1

'MsgBox determinant

I(1, 1) = torque(1)

I(2, 1) = torque(2)

determinant1 = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

a(1) = determinant1 / determinant

'MsgBox a(1)

I(1, 1) = s Mod 11

I(2, 1) = s Mod 21

I(1, 2) = torque(1)

I(2, 2) = torque(2)

determinant2 = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

a(2) = determinant2 / determinant

'MsgBox a(2)

I(1, 2) = s Mod 12

I(2, 2) = s Mod 22

' Checking correctness of the solution:

For c = 1 To 2

MsgBox torque(c)

Next c

For c = 1 To 2

torque(c) = 0

For cc = 1 To 2

torque(c) = torque(c) + I(c, cc) \* a(cc)

Next cc

MsgBox torque(c)

Next c

GoTo 2

1 determiniantIsZero = 0

MsgBox "Determinant = 0, no solutions"

2 ThereAreSolusions = 2

Matrix algebra

Number times matrix

Sum of matrices

i,j = 1,2.

Minus is similar to plus for matrices.

i,j = 1,2.

Additive identity matrix is

Multiplicative identity matrix is

To multiply matrices A and B matrix A must have the same number of columns and B rows.

Relation links sets.

Question:

Binary relation R on the set {1 to e+2} is defined so that *a*R*b* holds if and only if

 *a* divides *b*, with NO remainder. Find the matrix and draw the graph.

 Is it reflexive, symmetric, anti-symmetric, transitive, composite?

Question:

Find

Question:

Prove the Triangular Number expression .

Question:

Prove the expression for

https://calculus12s.weebly.com/uploads/2/5/3/9/25393482/p2integration2vs2summation.docx

Number theory:

Question:

Find Highest Common Divisor and Lowest Common Multiple of e+4 and L+4.

Question:

Convert T to e+2 and L+2 counting systems.

n = 100

b = 7

d1 = n Mod b ^ 1

MsgBox d1

d2 = (n Mod b ^ 2 - d1) / b ^ 1

MsgBox d2

d3 = (n Mod b ^ 3 - b ^ 1 \* d2 - d1) / b ^ 2

MsgBox d3

d4 = (n Mod b ^ 4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 3

MsgBox d4

d5 = (n Mod b ^ 5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 4

MsgBox d5

d6 = (n Mod b ^ 6 - b ^ 4 \* d5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 5

MsgBox d6

d7 = (n Mod b ^ 7 - b ^ 5 \* d6 - b ^ 4 \* d5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 6

MsgBox d7

'd8 = (n Mod b ^ 8 - b ^ 6 \* d7 - b ^ 5 \* d6 - b ^ 4 \* d5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 7

'MsgBox d8

'd9 = (n Mod b ^ 9 - b ^ 7 \* d8 - b ^ 6 \* d7 - b ^ 5 \* d6 - b ^ 4 \* d5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 8

'MsgBox d9

'd10 = (n Mod b ^ 10 - b ^ 8 \* d9 - b ^ 7 \* d8 - b ^ 6 \* d7 - b ^ 5 \* d6 - b ^ 4 \* d5 - b ^ 3 \* d4 - b ^ 2 \* d3 - b ^ 1 \* d2 - d1) / b ^ 9

'MsgBox d10

Question:

Calculate the largest prime number you can using your own computer code.

n = 13

For i = 2 To Int(Sqr(n))

If n Mod i = 0 Then GoTo 1

Next i

MsgBox "prime"

GoTo 2

1 MsgBox "not prime"

2 Label2 = 2

Question:

Give prime factorization of s.

Dim p(9999), pf(9999)

mn = 2

nm = 9999

sn = 99107088

'

For i = 2 To Int(Sqr(sn))

If sn Mod i = 0 Then GoTo 11

Next i

MsgBox sn: MsgBox "is a prime number"

'Print #ii, sn, "is a prime number"

GoTo 333

11 abcdef = 1111

'nm = Int(Sqr(sn))

k = 0

For n = mn To nm

srn = Sqr(n)

isrn = Int(srn)

For i = 2 To isrn

If n Mod i = 0 Or srn = isrn Then GoTo 1

Next i

k = k + 1

p(k) = n

1 Next n

'

'MsgBox k

'

For i = 1 To k

'Print #ii, p(i)

Next i

For i = 1 To k

pf(i) = 0

Next i

srn = Sqr(sn)

isrn = Int(srn)

csn = sn

For i = 1 To k

Do While csn Mod p(i) = 0

csn = csn / p(i)

pf(i) = pf(i) + 1

Loop

111 Next i

For iiii = 2 To Int(Sqr(csn))

If csn Mod i = 0 Then GoTo 1111

Next iiii

ptc = 1

For i = 1 To k

'If pf(i) <> 0 Then ptc = ptc \* p(i) ^ pf(i): Print #ii, i, pf(i), p(i)

If pf(i) <> 0 Then ptc = ptc \* p(i) ^ pf(i)

'If pf(i) <> 0 Then Print #ii, p(i), "^", pf(i), "\*"

If pf(i) <> 0 Then MsgBox p(i): MsgBox "^": MsgBox pf(i): MsgBox "\*"

Next i

2 gfgfhgfdr = 5567

If ptc = 1 Then MsgBox sn: MsgBox "is a prime number": GoTo 333

ptc = ptc \* csn

'Print #ii, csn, "^ 1"

MsgBox csn: MsgBox "^ 1"

GoTo 22

1111 abcd = 1

For i = 1 To k

'Print #ii, i, pf(i), p(i)

Next i

22 gfgfhgfdr = 5567

'Print #ii, sn, ptc

If sn = ptc Then MsgBox "corrrect"

If sn <> ptc Then MsgBox "wrong"

333 Label = 333

Question:

Calculate C(9,e) and P(7,e). Give all the options for C(e+3,e).

Question:

In how many ways can you answer an exam with m+1 questions

 each of which has e+1 options for the answer?

Question:

Draw the histogram of tossing L+2 fair coins. Draw the histogram of the first e+3 digits of π.

Question:

Draw the histogram of adding random between e+2 times.

Question:

Give the histogram of Benford of the first digit of e+2 the most populated countries.

worldometers.info/world-population/population-by-country/