VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION

ANNUAL RESEARCH JOURNAL

ISSN(ONLINE): 2581-7280

# SOFTWARE BASED CALCULATION OF CAPACITY OUTAGE OF GENERATING UNITS.

Ashish Mungekar[1], Sukanya Naik[2], Ashit Nair[3], Rahul Abhyankar[4]

[1] *(Department of Electrical Engineering, VIVA Institute of Technology, India)*
[2] *(Department of Electrical Engineering, VIVA Institute of Technology, India)*
[3] *(Department of Electrical Engineering, VIVA Institute of Technology, India)*
[4] *(Department of Electrical Engineering, VIVA Institute of Technology, India)*

**Abstract :** *The main theme of the project is to develop software for calculating the reliability & capacity outage table for generation purposes. The method for the calculation is quite lengthy, complex & a high possibility to get a human error during the calculation. The methods used to calculate reliability & capacity outage are Digital Method, Partial Binomial Method & Recursive Method, this method is highly recommended, but can be complex during the actual calculation. To justify the need for this method & also to remove the human error factor during quicker & better calculation, the software is made with the help of the python software. The python-based website will be easily accessible to use to any sort of user, choosing python program was a better option as it does not compile but interprets the calculation are in constant runtime with the input of values, this program helps in developing highly complex calculation which is up to many decimal points.*

**Keywords -** *Calculation, Capacity Outage, Generators, Python, Reliability.*

## I. INTRODUCTION

This project aims to design and compile an efficient and effective calculation method to be used in real-life calculations. The object of capacity outage evaluation is to derive suitable measures criteria and indices of reliable and dependable performance based on component outage data and configuration. A bulk generation model must consider the size of the generation reserve and serve outage of current. Outage in generating results in units being removed from service to be repaired or replaced or in case of heavy load. Such a system can comprise the ability of the system to supply the load and hence affect system reliability. Hence, we need to calculate the capacity of the outage of the system to know the reliability of the system. The calculating capacity outage is one of the lengthy processes and also cause human errors, developing software for computers with the help of programming language will provide ease in calculating of Reliability of generators. It will be useful for both students and professors as well as professionals to calculate power generation efficiency and generation reliability. this method consists of various methods such as digital, partial binomial method, binomial method, and recursive method. This program is used for increasing efficiency of calculation as calculation procedure is Lengthy and also human error is cut to a minimum.

## II. LITERATURE SURVEY

*[1] Yifan Tang:*

The costs and reliability of power distribution systems are beginning to receive as much attention as those of power generation and transmission systems. Modem planning of these large-scale and complicated systems relies heavily on computers and mathematical optimization tools. The goal of modern power distribution system planning is to satisfy the growing and changing system load demand during the planning period and within operational constraints, economically, reliably and safely, by making optimized decisions on the following: voltage levels of the distribution network; locations, sizes, servicing areas, loads and building or expanding schedules of the substations; routes, conductor types, loads and building schedules of the sub transmission lines, feeders and other important

VIVA Institute of Technology
9th National Conference on Role of Engineers in Nation Building – 2021 (NCRENB-2021)

*[2] Anirban Sarkar et al.:*

With the advent of new mobile technologies, the mobile application industry is advancing rapidly. Consisting of several operating systems like Symbian OS, iOS, blackberry, etc., Latest smart devices OS is recognized as the most widely used, popular and user-friendly mobile platform. Developers can make use of existing java IDEs which provides flexibility to the developers. Java libraries are predominant in the process of third-party application development. Cross-platform approaches make sure that developers do not have to develop platform-dependent applications. With the help of these approaches, an application can be deployed to several platforms without the need for changes in coding. These applications do not have to go through rigorous security checks. In this paper, a layered approach for latest application development along with various cross platform approaches is discussed.

*[3] Federico Milano:*

The basic requirements that a programming language has to satisfy to be eligible for scientific studies and, in particular, for power system analysis, are the availability of efficient and easy-to-use libraries. The requirements above reduce the choice to a only a handful of programming languages. This is clearly captured by the software tools for power system analysis that are currently actively developed. Neglecting proprietary software tools, that are out of the scope of this paper, open-source packages are mainly developed in scientific languages, example, MATLAB, and in well-structured system languages, example, Java. An in-depth discussion about advantages and drawbacks of scientific and system programming languages is given in.

## III. DESIGN METHODOLOGY

### 3.1 Working

In this project we use two methods which are python for the calculation of a capacity outage of generating units, the user interface will accept input from the user and give quick answers for the long and complex method of calculation which are most commonly used for capacity outage. Users will be given four options/methods to choose from. Each method will ask for required inputs from the user for calculation. The program codes will analyse every parameter before displaying the correct answer/values to the user.

### 3.2 Capacity Outage Probability Tables

The generation model required in the loss of load approach is sometimes known a Capacity Outage Probability Table. As the name suggests, it is a simple array capacity levels and the associated probabilities of existence. Capacity outage probability table can be formed by two method:
•Binomial Distribution [All units should be identical and then it can be used].
•Digital Method. [Any unit can be calculated if limited units are present].

### 3.3 Flowchart

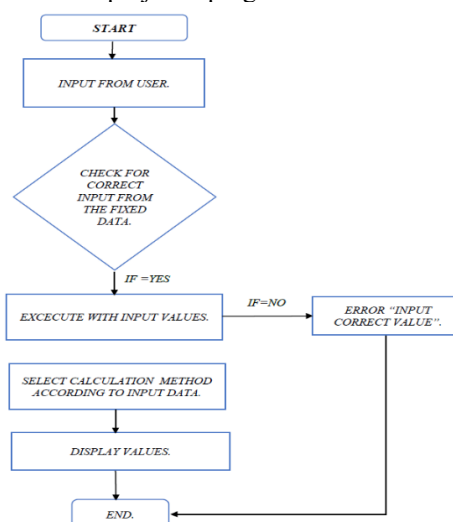The following is the design flowchart for the project's programs that will be used for the coding:



Fig 1: Flowchart for programs.

VIVA-Tech International Journal for Research and Innovation
ISSN(Online): 2581-7280

*Volume 1, Issue 4 (2021)*
*Article No. X*
*PP xx-xx*

VIVA Institute of Technology
9th National Conference on Role of Engineers in Nation Building – 2021 (NCRENB-2021)

### 3.4 Binomial Distribution Method

The first step is calling the math module. Math module is called with the help of the import function. Import function in python helps us import the built-in modules pre-installed in python. Math module is one of the many modules that are built in beforehand in the python standard library. Math function is used to access mathematical functions in Python. All methods of this functions are used for integer or real type objects and not for complex numbers. These built-in modules however limited helps us achieve sophistication in our program. Once the module is called, we take all the necessary data input required to solve the problem. To solve this problem in a more sophisticated and simpler way we have used the for loop. For loop is used for iterating the list. The for loop helps us iterate the sequence and reduces the time of execution required to solve it over and over with different values. We have then created a formula to execute and obtain the final output required. To create this formula, we call the math module in the first step as functions such as pow which is used to denote the power of a number cannot be used without calling the math module. Once the output is obtained, we then append it in a list we created so that it could be printed systematically. The append function helps create the list by adding the derived outputs to the list.

For the theoretical illustration, we take the following example.

A generating system contains four units of 40 MW having an FOR value of 0.03.
This example is solved by using the formula $P_g = {}^nC_g (F)^g (A)^{n-g}$, where n= no of generator g = state of the generator F = FOR and A = availability (A=1-F).

Table 1: Theoretical Calculation for Binomial Method.

| State | Calculation | Capacity outage (MW) | Probability |
|---|---|---|---|
| 0 | $P_0 = 4C0 * 0.03^0 * 0.97^{4-0}$ | 0 | 0.88529281 |
| 1 | $P_1 = 4C1 * 0.03^1 * 0.97^{4-1}$ | 40 | 0.10952076 |
| 2 | $P_2 = 4C2 * 0.03^2 * 0.97^{4-2}$ | 80 | 0.00508086 |
| 3 | $P_3 = 4C3 * 0.03^3 * 0.97^{4-3}$ | 120 | 0.00010476 |
| 4 | $P_4 = 4C4 * 0.03^4 * 0.97^{4-4}$ | 160 | 0.00000081 |

Executed illustration of the same example using software-based calculation.



```
C:\Windows\System32\cmd.exe

Microsoft Windows [Version 10.0.19042.746]
(c) 2020 Microsoft Corporation. All rights reserved.

C:\Users\Ashish Mungekar\Desktop\project codes(python)\completed codes>py binomial.py
CAPACITY OUTAGE TABLE THROUGH BINOMIAL DISTRIBUTION
ENTER THE MW VALUE OF GENERATOR :- 40
ENTER NUMBER OF GENERATORS :- 4
ENTER THE VALUE OF FOR :- 0.03
Capacity outage(MW)     Probability
0                       0.885292810000
40                      0.109520760000
80                      0.005080860000
120                     0.000104760000
160                     0.000000810000
```

Fig 2: Practical Calculation on Software using Binomial Distribution.

VIVA-Tech International Journal for Research and Innovation
ISSN(Online): 2581-7280

*Volume 1, Issue 4 (2021)*
*Article No. X*
*PP xx-xx*

VIVA Institute of Technology
9th National Conference on Role of Engineers in Nation Building – 2021 (NCRENB-2021)

### 3.5 Digital Distribution Method

With this method capacity outage of any generator, the unit can be calculated. Although digital method is used when the number of generators is limited. Currently, this method can be used to calculate the probability distribution of up to 4 generating units. The code uses the def type statement and elif loop for purpose of ease. It's a statement, a def can appear anywhere in a statement. It can even be nested in other statements. The statement block becomes the function's body. Once we have created the statements, we have applied the elif loop so that we could run the statement of our choice. The elif statement is a combination of else and if statement. An else statement contains the block of code that executes if the conditional expression in the if statement resolves to 0 or a false value. The else statement is an optional statement and there could be at most only else statement following if.

For theoretical illustration, we take the following example

A generating system has two units of 30 MW having FOR value of 0.06 and availability of 0.94 and one unit of 45 MW having FOR value of 0.09 and availability of 0.91.

Since we have 3 generator units in total, we will obtain 8 different probabilities. In the below table 0 means availability and 1 means unavailability which is denoted by FOR value

Table 2: Theoretical Calculation for Digital method.

| State | Generator 1 | Generator 2 | Generator 3 | Availability/Unavailability | Probability |
|-------|-------------|-------------|-------------|------------------------------|-------------|
| 1 | 0 | 0 | 0 | 0.94*0.94*0.91 | 0.804076 |
| 2 | 0 | 0 | 1 | 0.94*0.94*0.09 | 0.079524 |
| 3 | 0 | 1 | 0 | 0.94*0.06*0.91 | 0.051324 |
| 4 | 0 | 1 | 1 | 0.94*0.06*0.09 | 0.005076 |
| 5 | 1 | 0 | 0 | 0.06*0.94*0.91 | 0.051324 |
| 6 | 1 | 0 | 1 | 0.06*0.94*0.09 | 0.005076 |
| 7 | 1 | 1 | 0 | 0.06*0.06*0.91 | 0.003276 |
| 8 | 1 | 1 | 1 | 0.06*0.06*0.09 | 0.000324 |

Executed illustration of the same example using software-based calculation.

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19042.746]
(c) 2020 Microsoft Corporation. All rights reserved.

C:\Users\Ashish Mungekar\Desktop\project codes(python)\completed codes>py digital.py
CAPACITY OUTAGE TABLE WITH DIGITAL METHOD
1.Two generators
2.Three generators
3.Four Generators
 Enter Your Choice:- 2
Enter FOR value of generator 1:-0.06
Enter FOR value of generator 2:-0.06
Enter FOR value of generator 3:-0.09
State Generator1 Generator2 Generator3 Probability
 1.        0          0          0        0.80407600 :
 2.        0          0          1        0.07952400 :
 3.        0          1          0        0.05132400 :
 4.        0          1          1        0.00507600 :
 5.        1          0          0        0.05132400 :
 6.        1          0          1        0.00507600 :
 7.        1          1          0        0.00327600 :
 8.        1          1          1        0.00032400 :
```

Fig 3: Practical Calculation on Software using Digital Method.

## IV. MATHEMATICAL ANALYSIS

Required formulas:

1. Conditions for all three Methods:

$$A+F=1 \qquad \text{Eq } 1$$

Where A = Availability & F = Unavailability.

2. Failure & Repair Rate

$$(FOR)= \frac{\lambda}{\lambda+\mu}. \qquad \text{Eq } 2$$

Where $\lambda$= Failure Rate & $\mu$= Repair Rate.

3. Theoretical formula for Binomial method: -

$$P_g = {}^{n}C_g\,(F)^g\,(A)^{n-g} \qquad \text{Eq } 3$$

where n= no of generator and g = state generator.

4. Mathematical Formula for combination: -

$$^{n}C_g = \frac{n!}{g!(n-g)!} \qquad \text{Eq } 4$$

5. Frequency: -

$$f_n = P_n(\mu+\lambda) \qquad \text{Eq } 5$$

## V. CONCLUSION

Hence, we designed an efficient and fast method of calculating the Capacity Outage of generation units. This method is far easier to use for students, professors and professionals as it simply requires the input of available basic data. The project is based on python and latest smart device platforms for easier access to all on both computers as well as latest smart devices. This program will reduce unwanted human error and will not skip any of the important steps while calculating and will provide accurate answers each time

## REFERENCES

[1] Lt Col Rahul Dutt Sharma, "*Python Tools for Big Data Analytics*" IJSR, *Vol 9, Issue 5*, May 2020.

[2] Akshansh Sharma, Firoj Khan, Deepak Sharma, Dr. Sunil Gupta, "*Python: The Programming Language of Future*" IJIRT, *Vol 6, Issue 12,* May 2020.

[3] Dr. Anupam Sharma, Archit Jain, Ayush Bahuguna, Deeksha Dinkar, "*Comparison and Evaluation of Web Development Technologies in Node.js and Django*" IJSR, *Vol 9, Issue 12*, December 2020.

[4] Anirban Sarkar, Ayush Goyal, David Hicks, Debadrita Sarkar and Saikat Hazra, "*Latest android Application Development: A Brief Overview of Latest android Platforms and Evolution of Security Systems*". Proceedings of the Third International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) *(I-SMAC 2019) IEEE Xplore*, IEEE 2019.

[5] Thiago R. Fernandes, Leonardo R. Fernandes, Tiago R. Ricciardi, Luis F. Ugarte and Madson C. de Almeida, "*Python Programming Language for Power System Analysis Education and Research*", IEEE 2018.

[6] Federico Milano, "*A Python-based Software Tool for Power System Analysis*". Senior Member, IEEE 2013.

[7] Yan Zhang, Yan Zhang, Eekeng Yu "*The Characteristics of Generator and Load in The Calculation of Network Loss Modification*", IEEE 2011.

[8] Zdena Dobesova, "*Programming language Python for data processing*", 2011 International Conference on Electrical and Control Engineering, IEEE 2011.

[9] Greg Lindstrom, "*Programming with Python*", IT Professional (*Volume: 7, Issue: 5,* Sept.-Oct. 2005), IEEE 2005.

[10] Yifan Tang, "*Power Distribution System Planning with Reliability Modelling and Optimization*" IEEE Transactions on Power Systems, *Vol. 11, No. 1*, February 1996.