Contingencies in Load Flow

EE5200
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Example
Term
Project
1. INTRODUCTION

Contingency analysis examines the loss of elements in a steady-state electrical network. This can consist of one outage, or several outages. When an outage occurs, network line currents are changed, and the new bus voltages and line currents are calculated. For most power systems, which are fairly complex, the most important characteristic to be observed from this type of analysis is whether voltages and currents are out of limit, rather their exact values. Line currents can overload the system. Voltages that are out of limit can result in further outages due to system imbalance.

Approximations can often be made, since the exact current and voltage values are not required. Among these approximations are the assumption that the network is purely reactive, negligible effect of line charging transformers and off-nominal tap-changing transformers, and assumption of a linear system. This simplifies calculation of the line-outage distribution factors of a system. The distribution factor of a line is the change in current as a fraction of the preoutage current on an out of service line. This paper looks at calculation of distribution factors for single (one element out of service) and multiple (two or more elements out of service) contingencies. Contingency analysis of a 9-bus IEEE standard system using ASPEN simulation software will then be discussed.

II. SINGLE CONTINGENCIES

The first type of contingency is a single contingency. One transmission line is out of service. Initially there will be a transient current and voltage change. However, this is for a very short period of time. Contingency analysis is primarily concerned with what happens once these transient conditions are past, and looks at the steady-state operating conditions.

One method of calculation is using the system Zbus in which an initial power-flow solution, the state estimate, is known. The system load and generation is put in terms of current injections. An approximation that the network is composed of series impedances.

The line currents are changed by an injected current into a bus. For instance, if current is injected into a bus \( m \) and changes by \( \Delta I_m \), current flowing through the line from a bus \( i \) to a bus \( j \) is:

\[
\Delta I_{ij} = K_{ij,m} M_m
\]

(1)

where \( K_{ij,m} \) is known as the current-injection distribution factor, and is defined by:

\[
K_{ij,m} = \frac{\Delta I_{ij}}{\Delta I_m} = \frac{(Z_{im} - Z_{jm})}{Z_c}
\]

(2)

and \( Z_c \) is the impedance of the line between bus \( i \) and bus \( j \). For unacceptable line currents, overload can be corrected by reducing injected current at one bus and increasing the injected current at another bus. This is due to the superposition principle that can be employed under the assumption of a linear system. If currents are injected at both a bus \( p \) and a bus \( q \), the current from bus \( i \) to \( j \) will be:
$$\Delta I_g = K_{i,p} \Delta I_p + K_{i,q} \Delta I_q$$

Thus, if \(K_{i,p} \Delta I_p\) and \(K_{i,q} \Delta I_q\) are equal and opposite, the current will not change at all, and the current injection distribution factor may also be known as the current-shift distribution factor. The distribution factor is important for practical considerations. Using tables of known distribution factors, the reaction of buses to currents injected elsewhere in the system can be predicted.

When an impedance is removed because of a transmission line going out of service, the impedance matrix can be modified by adding the negative of that impedance between its buses, since the parallel combination goes to infinity, representing an open circuit. For a line impedance of \(Z_e\), the current from bus \(m\) to \(n\) is:

$$I_{mn} = (V_n - V_m) / Z_e$$  \hspace{2cm} (4)

$$V = \begin{bmatrix} V_1 \\ \vdots \\ V_m \\ V_n \\ V_p \\ V_q \\ \vdots \\ V_N \end{bmatrix}, \begin{bmatrix} \bar{1} \\ \cdots \\ \bar{m} \\ \bar{n} \\ \bar{p} \\ \bar{q} \\ \cdots \\ \bar{N} \end{bmatrix}, \begin{bmatrix} Z_{11} & \cdots & Z_{1m} & Z_{1n} & Z_{1p} & Z_{1q} & \cdots & Z_{1N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ Z_{m1} & \cdots & Z_{mm} & Z_{mn} & Z_{mp} & Z_{mq} & \cdots & Z_{mN} \\ Z_{n1} & \cdots & Z_{nm} & Z_{nn} & Z_{np} & Z_{nq} & \cdots & Z_{nN} \\ Z_{p1} & \cdots & Z_{pm} & Z_{pn} & Z_{pp} & Z_{pq} & \cdots & Z_{pN} \\ Z_{q1} & \cdots & Z_{qm} & Z_{qn} & Z_{qp} & Z_{qq} & \cdots & Z_{qN} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ Z_{N1} & \cdots & Z_{Nm} & Z_{Nn} & Z_{Np} & Z_{Nq} & \cdots & Z_{NN} \end{bmatrix}, \begin{bmatrix} I_1 \\ \vdots \\ I_m \\ I_n \\ I_p \\ I_q \\ \vdots \\ I_N \end{bmatrix}$$

$$V = \begin{bmatrix} V_1 \\ \vdots \\ V_m \\ V_n \\ V_p \\ V_q \\ \vdots \\ V_N \end{bmatrix}, \begin{bmatrix} \bar{1} \\ \cdots \\ \bar{m} \\ \bar{n} \\ \bar{p} \\ \bar{q} \\ \cdots \\ \bar{N} \end{bmatrix}, \begin{bmatrix} Z_{11} & \cdots & Z_{1m} & Z_{1n} & Z_{1p} & Z_{1q} & \cdots & Z_{1N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ Z_{m1} & \cdots & Z_{mm} & Z_{mn} & Z_{mp} & Z_{mq} & \cdots & Z_{mN} \\ Z_{n1} & \cdots & Z_{nm} & Z_{nn} & Z_{np} & Z_{nq} & \cdots & Z_{nN} \\ Z_{p1} & \cdots & Z_{pm} & Z_{pn} & Z_{pp} & Z_{pq} & \cdots & Z_{pN} \\ Z_{q1} & \cdots & Z_{qm} & Z_{qn} & Z_{qp} & Z_{qq} & \cdots & Z_{qN} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ Z_{N1} & \cdots & Z_{Nm} & Z_{Nn} & Z_{Np} & Z_{Nq} & \cdots & Z_{NN} \end{bmatrix}, \begin{bmatrix} I_1 \\ \vdots \\ I_m \\ I_n \\ I_p \\ I_q \\ \vdots \\ I_N \end{bmatrix}$$

**Figure 1**: Voltage, current, and impedance matrices for generic system

The preoutage current from bus \(m\) to bus \(n\) can be expressed from the Thevenin Equivalent circuit found by using the impedance matrix in Figure 1:

$$I_a = (V_m - V_a) / (Z_{mm} + Z_{mn} - 2Z_{mn}) = (V_m - V_a) / (Z_{mm} - Z_a)$$  \hspace{2cm} (5)

This current has the same effect as injecting compensating currents of \(-I_a\) and \(I_a\) at buses \(m\) and \(n\), respectively.
From Equation (3), the current change in the line from bus $i$ to bus $j$ is:

$$\Delta I_{ij} = K_{ij,\text{o}} \Delta I_{m} + K_{ij,\text{s}} \Delta I_{n} = \frac{\{(Z_{in} - Z_{in}) - (Z_{jn} - Z_{jn})\} I_{o}}{Z_{e}}$$  \hspace{1cm} (6)$$

Placing the expression from Equation (5) in for $I_{o}$ in Equation (6) gives:

$$\Delta I_{ij} = \frac{\{(Z_{in} - Z_{in}) - (Z_{jn} - Z_{jn})\} I_{n}}{Z_{e}} \cdot \frac{(V_{m} - V_{n})}{(Z_{h,nn} - Z_{q})}$$  \hspace{1cm} (7)$$

From Equations (4) and (7), the change in current between bus $i$ and bus $j$ is:

$$\Delta I_{ij} = \frac{(Z_{a} / Z_{o})}{Z_{e}} \cdot \frac{((Z_{in} - Z_{in}) - (Z_{jn} - Z_{jn}))}{(Z_{h,nn} - Z_{o})} I_{nn}$$  \hspace{1cm} (8)$$

If this current change is observed as a ratio of the preoutage current, it can be defined as the line-outage distribution factor $L_{ij,\text{nn}}$:

$$L_{ij,\text{nn}} = \Delta I_{ij} / I_{nn}$$  \hspace{1cm} (9a)$$

$$= \frac{(Z_{a} / Z_{o})}{Z_{e}} \cdot \frac{((Z_{in} - Z_{in}) - (Z_{jn} - Z_{jn}))}{(Z_{h,nn} - Z_{o})}$$  \hspace{1cm} (9b)$$

Tables of these outage distribution factors can be predetermined from the impedance matrix, and can show the change in current in lines due to a fault at a specific line, in this case line $m-n$.

**III. MULTIPLE CONTINGENCIES**

Multiple contingencies occur when two or more transmission lines are put out of service at the same time. In analysis of these types of contingencies, distribution factors are again used. The first contingency distribution factors can be combined in a manner that allows the calculation of double contingencies.

**A. Generation-Shift Double Contingency**

As stated previously, if an outage that occurs on line $m-n$ causes an outage on line $i-j$, the current can be reduced by simultaneously decreasing injected current into some bus $p$, and increasing injected current into bus $q$. This is achieved by shifting generation from a power plant at bus $p$ to a
plant at bus \( q \). One type of double contingency is a case that depends on both a line outage, and a shift in generation to alleviate the problem. Continuing with the assumption of a linear model, the outage and subsequent current shift will have the same effect on the overloaded line independent of which event occurred first. In the interest of ease of calculation, the current shift is considered first, then the outage. The line current change in lines \( m-n \) and \( i-j \) can be found by Equation (3), and expressed as:

\[
\Delta I_{ij} = K_{ij,p} \Delta I_p + K_{ij,q} \Delta I_q \tag{10a}
\]

\[
\Delta I_{mn} = K_{mn,p} \Delta I_p + K_{mn,q} \Delta I_q \tag{10b}
\]

\( \Delta I_p \) and \( \Delta I_q \) are the values of proposed changes in the injected currents at buses \( p \) and \( q \). This current shift results in new values of line currents in \( m-n \) and \( i-j \):

\[
\Delta I'_{ij} = I_{ij} + \Delta I_{ij} \tag{11a}
\]

\[
\Delta I'_{mn} = I_{mn} + \Delta I_{mn} \tag{11b}
\]

Using the single contingency distribution factor \( L_{ij,mn} \), the current through line \( i-j \) can be calculated for the case of line \( m-n \) being out of service:

\[
\Delta I'_{ij} = L_{ij,mn} \Delta I_{mn} - L_{ij,mn} I_{ma} + L_{ij,mn} \Delta I_{mn} \tag{12}
\]

One current change in \( i-j \) is caused by the current shift. Another change is caused by the actual outage of line \( m-n \). The total change in current is shown in Equation (12), and the total current through \( i-j \) is calculated as:

\[
I'_{ii} = I'_{ij} + \Delta I'_{ij} \tag{13a}
\]

\[
= (I_{ij} + \Delta I_{ij}) + (L_{ij,mn} I_{mn} + L_{ij,mn} \Delta I_{mn}) \tag{13b}
\]

\[
= [I_{ij} + L_{ij,mn} I_{mn}] + \Delta I_{ij} + L_{ij,mn} \Delta I_{mn} \tag{13c}
\]

\( I_{ij} + L_{ij,mn} I_{mn} \) is the current change due to the outage alone. The term \( \Delta I_{ij} + L_{ij,mn} \Delta I_{mn} \) then account for the proposed generation shift. Using substitution from Equations (10), the current due to the current shift can then be expressed as:

\[
\Delta I'_{ij} = (K_{ij,p} + L_{ij,mn} K_{mn,p}) \Delta I_p + (K_{ij,q} + L_{ij,mn} K_{mn,q}) \Delta I_q \tag{14}
\]

Combining terms, the single contingency generation-shift distribution factors have now been used to calculate distribution factors for a double contingency:

\[
K'_{ij,p} = K_{ij,p} + L_{ij,mn} K_{mn,p} \tag{15a}
\]

\[
K'_{ij,q} = K_{ij,q} + L_{ij,mn} K_{mn,q} \tag{15b}
\]

Equations (15) show the generation-shift distribution factors for a double-contingency case in terms of the known single-contingency distribution factors. After these results are tabulated, it is possible for system operators to determine the best method to eliminate overload due to the outage.
B. Two Lines Out of Service

A second type of multiple contingency occurs when one line is out of service and a second line trips. If the first line is again \( m-n \), and the second line is between \( p \) and \( q \), the outage can be accounted for be adding the negative of their respective line impedances between each of their two buses. This is analogous to adding new lines to a system. For line impedances of \( Z_a \) for line \( m-n \) and \( Z_b \) for line \( p-q \), the effect of adding negative impedance is:

\[
\begin{bmatrix}
Z_{th,mn} - Z_a & (Z_{mp} - Z_{mq})-(Z_{mp} - Z_{mq}) \\
(Z_{pm} - Z_{pn}) - (Z_{pm} - Z_{pq}) & Z_{th,pq} - Z_b
\end{bmatrix}
\begin{bmatrix}
I_a \\
I_b
\end{bmatrix}
= \begin{bmatrix}
V_m - V_n \\
V_p - V_q
\end{bmatrix}
\tag{16}
\]

\( V_m, V_n, V_p, \) and \( V_q \) are the bus voltages, as shown in Figure 2.

\[
I_{mn} = (V_m - V_n) / Z_a \tag{17a}
\]

\[
I_{pq} = (V_p - V_q) / Z_b \tag{17b}
\]

From Equations (16) and (17), the new distribution factors are calculated. First, each row is divided by the diagonal element of the \( Z \) impedance matrix:

\[
\begin{bmatrix}
1 & (Z_{mp} - Z_{mq})-(Z_{mp} - Z_{mq}) \\
(Z_{pm} - Z_{pn}) - (Z_{pm} - Z_{pq}) & Z_{th,pq} - Z_b
\end{bmatrix}
\begin{bmatrix}
I_a \\
I_b
\end{bmatrix}
= \begin{bmatrix}
V_m - V_n \\
V_p - V_q
\end{bmatrix}
\tag{18}
\]

The non-unity terms are then put in terms of the line-outage distribution factors in the following manner:

\[
L_{mq,mn} = -(Z_a / Z_b) \left[ \frac{(Z_{pm} - Z_{pn})-(Z_{pm} - Z_{pq})}{(Z_{th,mn} - Z_a)} \right] \tag{19a}
\]

\[
L_{mn,pq} = -(Z_a / Z_b) \left[ \frac{(Z_{mp} - Z_{mq})-(Z_{mp} - Z_{mq})}{(Z_{th,mn} - Z_b)} \right] \tag{19b}
\]

Combining Equations (18) and (19), the result is:

\[
\begin{bmatrix}
1 \\
-Z_a / Z_b L_{mq,mn}
\end{bmatrix}
\begin{bmatrix}
I_a \\
I_b
\end{bmatrix}
= \begin{bmatrix}
V_m - V_n \\
Z_{th,mn} - Z_a \\
V_p - V_q \\
Z_{th,pq} - Z_b
\end{bmatrix}
\begin{bmatrix}
I_{mn} \\
I_{pq}
\end{bmatrix}
\tag{20}
\]

\( I_a \) and \( I_b \) are compensating currents that can be treated as injections into the system, and can be found by solving Equation (20):

\[
\begin{bmatrix}
I_a \\
I_b
\end{bmatrix}
= 1 / (1 - L_{pq,im} L_{mn,pq}) \begin{bmatrix}
Z_a & \frac{Z_a}{Z_{th,mn} - Z_a} \\
Z_{th,mn} & Z_b \frac{Z_{th,pq} - Z_b}{Z_{th,pq} - Z_b}
\end{bmatrix}
\begin{bmatrix}
I_{mn} \\
I_{pq}
\end{bmatrix}
\tag{21}
\]
Now the current change $\Delta l_i$ due to the compensating current is found in order to determine the new outage distribution factors. These compensating currents can be thought of in the same way in which they are shown in Figure 2, and the bus voltage changes at $i$ and $j$ are:

$$\Delta V_i = (Z_{ii} - Z_{im})I_a + (Z_{ij} - Z_{ip})I_b$$  \hspace{1cm} (22a)

$$\Delta V_j = (Z_{ji} - Z_{jm})I_a + (Z_{jj} - Z_{jp})I_b$$  \hspace{1cm} (22b)

Since the line impedance between $i$ and $j$ is $Z_{ij}$, the current change in terms of the compensation currents is:

$$\Delta I_{ij} = \left[ \frac{(Z_{ii} - Z_{im}) - (Z_{jm} - Z_{jm})}{Z_c} \right] \left[ \frac{(Z_{ij} - Z_{ip}) - (Z_{ji} - Z_{jp})}{Z_c} \right] \begin{bmatrix} I_a \\ I_b \end{bmatrix}$$  \hspace{1cm} (23)

$$L_{ij,mn} = -(Z_a / Z_c) \left\{ (Z_{im} - Z_{in}) - (Z_{jm} - Z_{jn}) / (Z_{im} - Z_{jn}) \right\}$$  \hspace{1cm} (24a)

$$L_{ij,pq} = -(Z_b / Z_c) \left\{ (Z_{ip} - Z_{iq}) - (Z_{jp} - Z_{jq}) / (Z_{ip} - Z_{iq}) \right\}$$  \hspace{1cm} (24b)

Combining Equations (23) and (24) yields the change in current in terms of the line-outage distribution factors:

$$\Delta I_{ij} = \left[ \frac{Z_{th,mn} - Z_a}{Z_a} L_{ij,mm} \frac{Z_{th,mn} - Z_b}{Z_b} L_{ij,pq} \right] \begin{bmatrix} I_a \\ I_b \end{bmatrix}$$  \hspace{1cm} (25)

Using Equation (21), $\Delta l_i$ can be expressed in the form of the effective line-outage distribution factors for which line $i-j$ is affected by both $m-n$ and $p-q$ being tripped out at the same time.

$$\Delta l_i = \left[ \frac{L_{ij,mm} + L_{ij,pq}L_{pq,mm}}{1 - L_{pq,mm}L_{mm,pq}} \right] \begin{bmatrix} I_a \\ I_b \end{bmatrix}$$  \hspace{1cm} (26)

So the final line-outage distribution factors for outages of both line $m-n$ and line $p-q$ are:

$$L_{ij,mm} = \frac{L_{ij,mm} + L_{ij,pq}L_{pq,mm}}{1 - L_{pq,mm}L_{mm,pq}}$$  \hspace{1cm} (27a)

$$L_{ij,pq} = \frac{L_{ij,mm} + L_{ij,mm}L_{mm,pq}}{1 - L_{pq,mm}L_{mm,pq}}$$  \hspace{1cm} (27b)
IV. ASPEN SIMULATION OF THE IEEE 9-BUS SYSTEM

![Diagram of the 9-Bus System](image)

**Figure 3.** IEEE 9-bus system used in ASPEN simulation

The 9-bus IEEE system used in the ASPEN load flow program is shown in Figure 3. This system was simulated for both single and multiple contingencies. The system as found in the ASPEN software proved to be a very robust design in which there were no single contingencies that caused problems. In order to view any potential contingencies, the loads were increased incrementally by a fixed percentage until a single contingency occurred. The first and only single contingency occurred when the loads were doubled. The initial and simulated loads are shown in Table 1.

<table>
<thead>
<tr>
<th>BUS</th>
<th>Initial P (kW)</th>
<th>Initial Q (kVAR)</th>
<th>Simulated P (kW)</th>
<th>Simulated Q (kVAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennessee</td>
<td>7.6</td>
<td>1.6</td>
<td>15.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Claytor</td>
<td>21.7</td>
<td>12.7</td>
<td>43.4</td>
<td>25.4</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>5.8</td>
<td>2</td>
<td>11.6</td>
<td>4</td>
</tr>
<tr>
<td>Fieldale</td>
<td>94.2</td>
<td>19</td>
<td>188.4</td>
<td>38</td>
</tr>
<tr>
<td>Ohio</td>
<td>22.8</td>
<td>10.9</td>
<td>45.6</td>
<td>21.8</td>
</tr>
<tr>
<td>Reusens</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

**Table 1.** Initial and simulated loads for IEEE 9-bus system

Since contingency is primarily concerned with the number of out-of-limit voltages rather than their exact values, it is important to look at the worst-case scenarios. A tripped line that causes voltage problems on two buses is a worse case than one that causes problems on just one. The highest priority, then, is given to line outages that cause the highest number of out-of-limit voltages rather than
a lower number of more profound problems. The single contingency that causes the highest number of problems is thought of as the first worst case. The only single contingency for the IEEE 9-bus system with the loads shown in Table 1 is shown in Figure 4.

Figure 4: Simulation result for first worst case

For an outage in the line from Claytor to Fieldale, there are out of limit voltages at Tennessee, Nevada, and Ohio. This is the first worst case.

Once the first worst case is established, the system was simulated for multiple contingencies in the ‘n-1’ case. Table 2 summarizes the results of taking out lines when the first contingency is in effect.

<table>
<thead>
<tr>
<th>Line #</th>
<th>Location</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tennessee - Claytor</td>
<td>System does not converge</td>
</tr>
<tr>
<td>2</td>
<td>Tennessee - Nevada</td>
<td>System does not converge</td>
</tr>
<tr>
<td>3</td>
<td>Claytor - Nevada</td>
<td>System does not converge</td>
</tr>
<tr>
<td>4</td>
<td>3-W Transformer</td>
<td>Four low bus voltages</td>
</tr>
<tr>
<td>5</td>
<td>2-W Transformer</td>
<td>Four low bus voltages</td>
</tr>
<tr>
<td>6</td>
<td>Nevada - Arizona</td>
<td>Three low bus voltages</td>
</tr>
<tr>
<td>7</td>
<td>Nevada - Reusens</td>
<td>System does not converge</td>
</tr>
<tr>
<td>8</td>
<td>Nevada - Ohio</td>
<td>Outage at Ohio and Fieldale, no other out of limit voltage</td>
</tr>
<tr>
<td>9</td>
<td>Fieldale - Ohio</td>
<td>Outage at Fieldale, no other out of limit voltage</td>
</tr>
<tr>
<td>10</td>
<td>Arizona - Reusens</td>
<td>Four low bus voltages</td>
</tr>
</tbody>
</table>

Table 2: Results of double contingency simulation

If the line from Claytor to Fieldale is out and any one of lines 1-3 trips out, the system fails. The only line that does not affect the system when the first contingency is in effect is the Nevada-
Arizona line. The other lines cause outages and a significant number of out-of-limit voltages. The results of line simulations for numbers 4, 5, 6, 8, 9, and 10 are shown in Appendix A.

V. CONCLUSION

Load flow contingency analysis involves using multiple techniques in order to predict system performance in event of an outage. Two methods that were examined in this paper were the calculation of line-outage distribution factors for single contingencies, double contingencies when generation shift is being considered, and double contingencies when two transmission lines are out of service at the same time. This leads to tables of distribution factors that let system operators know what changes in line currents and bus voltages will occur for an outage at a given system element. A planner can then act accordingly to predict or alleviate system performance problems.

A second method for contingency analysis is the use of software simulations. To this end, ASPEN was used to simulate an IEEE 9-bus system. The first and second contingencies were then observed from the results of the simulations.

Much of this paper dealt with the calculation of distribution factors. Although further data processing in Matlab of the IEEE system used in the ASPEN simulations was not carried out as part of this project, it would be a useful method of tying the simulation and calculations together. By building the impedance matrix and performing calculations, the results of the load flow simulations could be compared to their calculated values.
REFERENCES


http://www.ee.washington.edu/research/pstca/


Figure A1: Three-winding transformer out of service in n-1 state

Figure A2: Two-winding transformer out of service in n-1 state
Figure A3: Nevada – Arizona line out of service in n-1 state

Figure A4: Nevada-Ohio line out of service in n-1 state
Figure A5: Ohio-Fieldale line out of service in n-1 state

Figure A6: Arizona - Reusens line out of service in n-1 state
EE 5200
Term Project Evaluation

Criteria:

1) Originality in approach and coverage of Topic/Application
   Independence selected, challenging topic.  
   
2) Organization/Grammar/Format/Spelling
   
3) Technical level befitting 5xxx-level course
   
4) Adequate use of figures, equations to explain concepts & theory
   
5) Complete concise coverage of chosen topic
   
6) Presentation materials & delivery

Comments:

Very pleased with your self-study skills, getting up to speed on contingency analysis (basis theory/calcs).