NPTEL course offered by IIT Madras

Risk and Reliability of Offshore structures

<u>**Tutorial 11: Risk analysis methods**</u>

Answer ANY FIVE questions   **Total marks: 25**

1.   Write short notes on Fault tree analysis (FTA)

Logical trees are actually useful in analyzing the overall risk and assessing the risk contributions. Fault trees and event trees are similar in many ways. Choice of using either fault tree or event tree analysis depends more on preferences within the given industry. This choice does not depend on the specific characteristics of the logical tree at all. Fault tree analysis can be applied only to a certain set of problems. No logical trees, in general can be applied to both qualitative and quantitative methods. Fault tree is based on deductive logic, whereas event tree is based on inductive logic. Deductive logic means looking backwards inductive logic means looking forward, which makes a fundamental and significant difference between both the logical trees in practical applications. Generally a combination of fault and event tree is typically used for reliability analysis. Fault tree is used to address the sequences of failure, which may lead to events with consequences. Event tree is used to represent the subsequent evolution of the consequences including inducing the events that induce such consequences. Event tree looks into more breakup and more focused towards the consequences inducing events, whereas fault tree if used in combination with event tree is generally required to address the sequence of failure, which is very important step in risk assessment.

2.   Explain the symbols used and logical gates used in Fault tree analysis
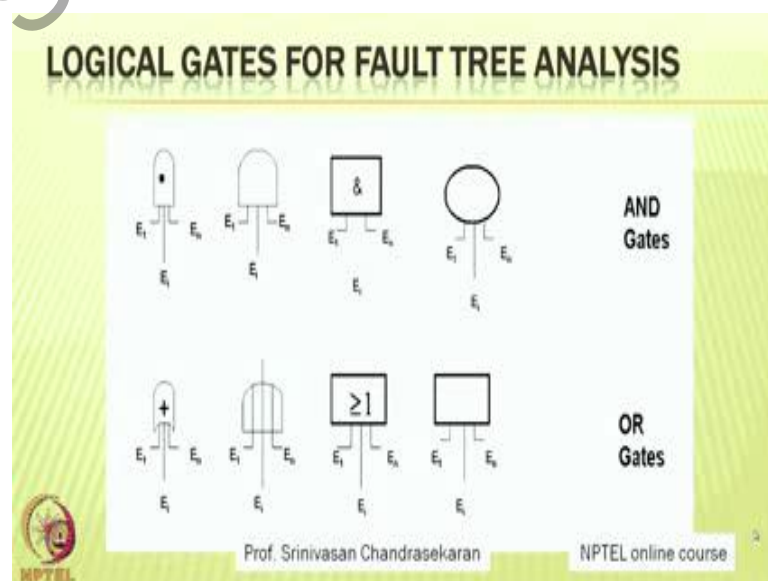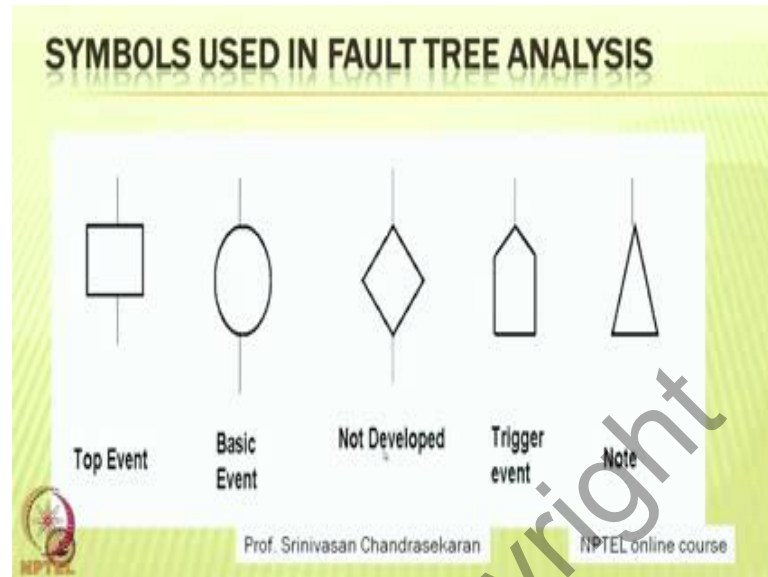
Figure shown above indicates logical gates, which are commonly used in fault tree analysis. For AND gates, output will always happen only if all input events occur whereas for an OR gate, output will be successful even if anyone input occurs.

3.

Above figure shows symbols used in FTA. Generally represented by a rectangle or a square is the top event while basic event has a specific probability of failure, which is indicated by an ellipse whose major axis is shown along the fault tree event. Any event that is not fully developed is indicated as a doubtful event with a rhombus where as a triggering event, which is called as an initiating event is indicated by a pyramid, as shown in the above figure. If a note need to be expressed related to any specific event, one can use a triangular box. Above gates can be combined to form a typical fault tree analysis. It is therefore important to note the connection of logical gates; whether it is connected by OR gate or AND gate.
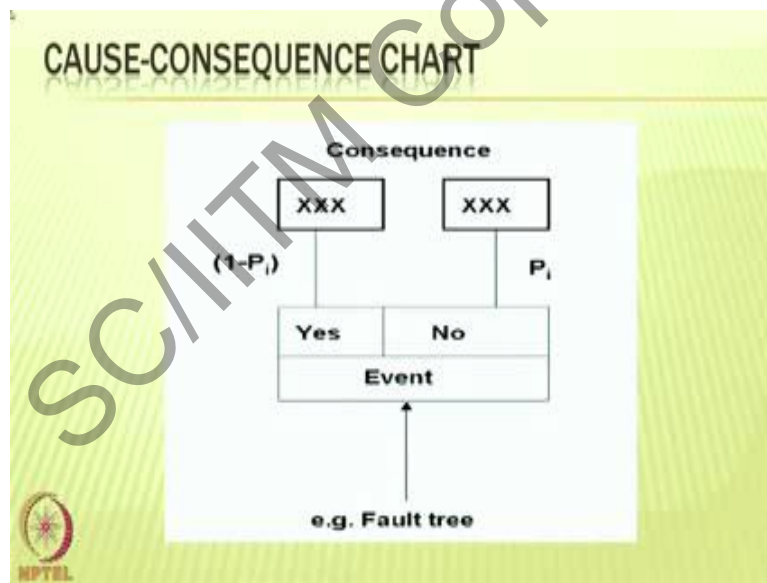
4.   Write short notes on Event Tree analysis

Event tree analysis is inductive algorithm, which progresses on the forward direction. Event tree is an actual representation of logical order of events, leading to some condition of interest for a considered system, generally looking forward for failure conditions. There are different states of the considered system as each state can have a multiple failure. This may lead to a probability of multiple modes of failure, which are dependent on many conditions associated with the consequence of each state. It is important that each failure condition or adverse condition should be also associated with its relative consequences. In this perspective, event tree analysis deviates from the fault tree in the following manner.

Let us say event tree actually starts from a basic initiating event and then develops from that point onwards until all possible states with the adverse consequences are reached. It develops until all possible states of adverse condition provoking adverse consequences are reached. The initiating event, which is the actual starting point of event tree may typically arise as a top event from fault tree analysis. Thus, initiating event can start from the top events in fault tree analysis. Hence, before constructing an event tree, event definitions and logical value should be known. Even before event tree is started, it is important to know details of elements of event tree analysis that may have discrete or continuous sample space.

5.   Write short notes on Cause-consequence analysis

Cause-consequence charts are alternate method of representing a combination of fault tree or event trees. The inter-relation between the fault tree and event tree becomes very important in such cases. Top event of the fault tree, which is called as initiating event (in case of event tree, it is represented by a rectangular gate with output being event of yes or no values) will lead to different set of consequences. Hence, most important benefits of the cause-consequence chart is that fault tree need not be expanded in the representation. Therefore, overview of risk analysis is improved to a greater extent.

The output will lead to yes or no variables, which can result to an event, which can be an example of an event of a fault tree.

6.   Write short notes on Decision trees

Decision trees are applied within a framework of decision theory, which is one of the basic frameworks of risk assessment. Risk analysis actually originates from a decision-making philosophy. In fact, within the Reliability framework, question-making ability is inherently present towards engineering judgment.

Hence, it is important to know that risk level should be predefined for process industries, as a mandatory part of international practice. Inherent presence of risk in offshore oil and gas exploration processes, when compared with acceptable risk, shall then enable the competent person to decide the course of action towards its prevention, mitigation or loss control. So, decision theory is applied when the risk present is compared with that of the acceptable level. Hence, one need to actually predefine the acceptable level of risk in offshore industry as per international practice. Risk in offshore industry is predefined using ALARP. More interestingly, predefined risk level should be also declared in public domain and approved by the local competent authority. It is important to note that predefined risk level is not at the liberty of the offshore industry but has to follow certain guidelines implemented by various international regulatory agencies. Company or the owner or the group of companies should declare the pre-acceptable risk in advance, with the approval of local government. To compare the risk involved in any specific case with that of the ALARP, decision making process, employing decision theories are very useful. This is generally carried out using decision trees.

7. Write short notes on consequence analyses

A consequence analysis is more or less a qualitative analysis, which explains the physical effects of accidents; various models are used to estimate this effect. The accident can be an oil spill, release of hazardous material etc., whose consequences are predicted using different models. Based on these predictions, damage ascertained could be of a different order. For example, it can be lethality, material loss etc. Consequence analysis deliberately attempts to find out the effect or the consequences of damage caused by different failure modes in particular to different perspective where risk assessment is also a part of it. Consequences of various physical effects are to be seen in a closer window. Consequence calculations can be divided into three parts: first part will illustrate determination of the source-strength parameters; second part will illustrate consequential effects; and third part three will give details of the damage or hazard distances. In case of any chemical fire release, one is more bothered about intensities of fire, devastating consequence caused by fire and how far and how long it would spread. All the above are part of consequence analysis. Consequential effects throw a brighter window in understanding many parameters, which are otherwise not looked upon in risk assessment. Mathematically, in risk assessment, consequence only becomes the multiplier in terms of estimating quantified values of risk; its effect is not viewed seriously. Hence, risk assessment using consequence analysis depends on essentially the choice of the material being released (accidentally).

8.