Model validation:

The validity of a model is always partially dependent upon the desired applications.

→ Empirical Validity: correspondance b/w measurements and simulations.

→ Theoretical validity: consistency of model with accepted theories

→ Pragmatic validity: Capability of a model to fulfill the desired purpose. eg. as part of regulator.

→ Heuristic Validity: potential for testing hypotheses, for the explanation of phenomena and for discovery of relationship.

⇒ direct validation based upon measured data.

– Validation should ensure the correspondence b/w the executable model and reality.

– To achieve this it is necessary to take measurements on real systems in order to compare these with the results of a simulation.

- If this model is predictively valid, it follows that the predictions are correct in relation to reality.
- It is quite possible for faulty models to produce correct predictions by coincidence. So we cannot say model is valid if false predictions are made.

⇒ Validation <u>based</u> upon <u>a Slm</u> identification:

- classified validation methods as identifiable and non identifiable models.
- If a model is clearly identifiable then the procedure of parameter estimation can be used to validate a predetermined model structure.
- A high standard deviation of the estimated parameters in the identification for various set of measured data can indicate an invalid model, but it can also indicate non-negligible measurement error.
- most procedures and tools for Slm identification are only suitable for linear models.

⇒ Validation based upon 'model distortion' approach.

- Similar as Validation by identification.
- The main idea behind this is to calculate the 'distortion' of parameters necessary to obtain simulation results that precisely correspond with the measurements for every point in time.
- The gap b/w nominal parameters and the newly determined parameters, which alter from one moment to next, becomes a measure for quality of the model.
- was originally used for validation of models for heavy water reactors.

⇒ Validation based upon Sensitivity analysis:

- It is not generally possible to precisely determine the value of the parameters of a simulation model.
- In this simplest case, the sensitivity 'S' is determined using the perturbation method for a property of circuit F and a parameter P, by varying parameter by ΔP and evaluating the change in the circuit: ΔF :

$$S = \frac{\partial F}{\partial P} \approx \frac{\Delta F}{\Delta P}$$

However it lead to problem, if F & p are close (or) equal to zero.

⇒ Validation based upon a monte - carlo Simulation :-

- For the parameters and their variations are not independent of each other with regard to their effect upon the events of the simulation.
- reasons related to running time it is not possible to itemise all combinations of parameter variations and subject each to a sensitivity analysis.
- It is generally not used for the validation of models, but for evaluation of yield of fabricated circuits taking into consideration the component tolerances.

⇒ Validation based upon model hierarchy:

- This method aims to achieve the validation of model based upon the validation of its components, whereby the interconnection of the components occurs directly within the model and thus is non critical in relation to validation.
- an example application for this is the rotor dynamics of a helicopter.

⇒ Validation based upon inverse model.

- An inverse model in the form of an ideal pilot calculates the necessary control of helicopter.
- This avoids the accumulation of faults. Thus the validity of helicopter model is demonstrated on basis of o/p's supplied from the inputs generated using inverse model.

Electro mechanics design: