Engineering Building Structures And Electric Circuit Equivalence

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Abstract *The purpose of this paper is to show that analysis of trusses (and hence that of bridges) can be effectively carried out using the three concepts of Basic Electric Circuit Analysis, namely the Superposition Theorem, Kirchhoff's Current Law and the Cut-set method.*

1. Narrative

The objective of this paper is to show that some of the techniques of basic electric circuit analysis can be used in the analysis of engineering structures like trusses, bridges and frames [1]. Specifically, the following techniques can be successfully employed to analyze the various forces in each arm of a give truss subjected to a number of forces.

1. Superposition Theorem: The principle of superposition is the starting point of linear system theory and can be applied to circuits and structures. This means that one force at a time can be considered making all other forces equal to zero. One can determine the contribution of each force to the reactions at the hinged ends by the equilibrium equations. Moreover, the concept of scaling can be applied in that first, the effect of a unit force can be determined. Then, the scaling factor is used to get the actual effect.
2. Kirchhoff's Current Law (KCL): This fundamental law of ciruit theory states that the vectorial sum of all currents at a node equals zero. Since force is analogous to current [2][3], this is equivalent to saying that the vectorial sum of the forces at any given point is zero. Given a joint, a phasor diagram of the various forces in each arm can be constructed. Each force is represented as a complex number. Application of KCL [4] results in the equilibrium equations. This is an alternative to the proportion formula used for analyzing trusses [1].
3. Cut-set analysis: Cut-set analysis [5] of an electric circuit is the surface generalization of KCL at a node. It involves "cutting" a circuit into subcircuits and analyzing each subcircuit at a time. This is equivalent to the method of sections of analyzing trusses where the truss is "cut" into sections and each section is analyzed at a time. For each section of a truss or subcircuit of a network, the equilibrium equations and KCL give the same result.

The foregoing discussion clearly shows that the three concepts of basic circuit analysis, namely Superposition, KCL and Cut-set analysis can be effectively used in the analysis of trusses. Thus, this paper makes a thrust at multidisciplinary engineering education by showing the equivalence of structures and circuits thereby depicting the isomorphism in the analysis techniques. It is suggested that courses on Statics and Circuits can be improved and looked at under one common analysis framework.

2. References

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0-7803-5643-8/99/$10.00 © 1999 IEEE