This paper proposes a novel and unified synthesis approach and design procedure for microwave filters with extracted pole and nonresonating node (NRN) technique. By introducing a general circuit topology, the traditional extracted pole and NRN filters can be unified to a general prototype. With the new design process, the exact mapping relationship between the electromagnetic (EM) model of the pole producing element and the circuit model can be achieved. All the physical dimensions of the filter structure can be obtained by a fully analytical approach. No full EM optimization or adjustment is needed in the filter design. A three pole TE_{101} mode waveguide filter with one finite transmission zero is designed to illustrate the new procedure. In addition, a seven-pole TE_{011} mode filter with four finite transmission zeros covering all three possible types of arrangements is designed and fabricated to demonstrate the versatility of the proposed method. The simulated and measured results verified the efficiency and the accuracy of the proposed design method.