Design a speed-controlled dc motor drive maintaining the field flux constant. The motor parameters and ratings are as follows:

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The converter is supplied from -phase ac at . The converter is linear, and its maximum control input voltage is . The tachogenerator has the transfer function . The speed reference voltage has a maximum of . The maximum current permitted in the motor is .

Solution

(i) Converter transfer function:

The rated dc voltage required is , which corresponds to a control voltage of . The transfer function of the converter is

(ii) Current transducer gain: The maximum safe control voltage is , and this has to correspond to the maximum current error:

(iii) Motor transfer function:

The subsystem transfer functions are

(iv) Design of current controller:

(v) Current-loop approximation:

Where:

The validity of the approximations is evaluated by plotting the frequency response of the closed-loop current to its command, with and without the approximations. This is shown in Figure 3.34. From this figure, it is evident that the approximations are quite valid in the frequency range of interest.

(vi) Speed-controller design:

The frequency responses of the speed to its command are shown in Figure 3.35 for cases with and without approximations. That the model reduction with the approximations has given a transfer function very close to the original is obvious from this figure. Further, the smoothing of the overshoot by the cancellation of the zero with a pole at is shown in Figure 3.36. This figure contains the approximated transfer function of third order for the speed to its command-transfer function and the one without any approximations. Again, the closeness of these two solutions justifies the approximations.

The time responses are important to verify the design of the controllers, and they are shown in Figure 3.37 for the case without smoothing and with smoothing. The case without any approximation is included here for the comparison of all responses.