

1. ⑤ In the σ'_a versus σ'_m plane, carefully draw the lines and write the equations for the following fatigue failure criteria: (a) Soderberg line, (b) modified Goodman line, (c) ASME-elliptic line, (d) Gerber line, and (e) Langer yield line.
 2. ② A shaft has the properties $S_e = 300$ MPa, $S_y = 480$ MPa, and $S_{ut} = 620$ MPa. The shaft is subjected to an alternating bending stress of 120 MPa, an alternating torsional stress of 90 MPa, and a steady torsional stress of 80 MPa. Find the factor of safety n_y guarding against a static failure.
 3. ③ For the shaft in Problem 2, find the factor of safety n_f guarding against a fatigue failure using (a) modified Goodman line, (b) ASME-elliptic line, (c) Gerber line.
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1. (SMAG Lines from GA to MS and equations) ① × 5 = ⑤

2. $\sigma'_{\max} = 317.96$ MPa $n_y = S_y / \sigma'_{\max} = 1.5096$ $n_y = 1.51$ ②

3.
$$\sigma'_a = \frac{1}{\sqrt{2}} \left[2\sigma_a^2 + 6\tau_a^2 \right]^{1/2} = 196.723 \text{ MPa}$$

$$\sigma'_m = \frac{1}{\sqrt{2}} \left[6\tau_s^2 \right]^{1/2} = 138.564 \text{ MPa}$$

(a) Modified Goodman line: $n_f = 1.14$ ①

(b) ASME-elliptic line: $n_f = 1.40$ ①

(c) Gerber line: $n_f = 1.38$ ①