Purpose of this Guide: To thoroughly prepare students for the exact types of problems that will be on Exam 1.

Exam Format: Closed book. The formulae below will be given. Students can expect 20% of the exam to be in the form of conceptual questions, while 80% will be computational. Time Limit: 50 minutes.

Given Formulae (these will be found on the exam):
Normal stress $\sigma = \frac{F}{A}$, where $F$ is the force that is normal to the cut and $A$ is the area of the cut.
Shear stress $\tau = \frac{V}{A}$, where $V$ is the force that is normal to the cut and $A$ is the area of the cut.

Lesson Coverage, Objectives, and Example Problems: The exam covers Lessons 2 through 5. The objectives are given below, with example problems/questions for each objective. Students are strongly advised to solve as many problems as possible from the Philpot textbook, sections 1.1 to 1.6. In addition to those problems and the problems below, three sample exams with solutions are found on the course webpage.

- Name the unknown loading resultants that may be present at a cut through a planar body or a three-dimensional body.
  1. (3 points) If a cut is taken at Point D, how many unknown internal forces or internal moments are present there?
     Given: A is a roller support, D is a point midway between A and B, B is a pinned connection, E is a point midway between B and C, C is a fixed support.

2. (3 points) For the previous beam, how many unknowns (internal forces, moments) are present at Point B?
3. (5 points) The previous beam has 4 unknown external reactions, yet is solvable by Statics. Show how these can be solved by Statics.
4. (3 points) What is the internal moment at Point B, for the beam below?

5. (3 points) TRUE or FALSE. For the previous beam, there is no internal shear force present at Point B.
6. (3 points) TRUE or FALSE. For the previous beam, there is not internal moment present in the beam over the roller support C.
7. (3 points) In general, what is the maximum number of unknown internal forces or moments that may be present at a cut of a two-dimensional problem?
8. (3 points) In general, what is the maximum number of unknown internal forces or moments that may be present at a cut of a three-dimensional problem?
9. (3 points) When analyzing the previous beam to determine the external support reactions, explain why it is necessary to cut the structure at point B.
10. (3 points) How many internal unknowns are there at cross-section B?
Solve internal resultant loadings (forces and moments) acting within planar machines and structures by taking cuts and applying equilibrium.

11. (15 points). Determine the internal moment that is present at point A for the beam below and indicate whether this moment causes compression on the top or on the bottom of the beam. Given: Point A is supported by a pin, while Point B is a roller support.

12. (15 points). Referring to the previous beam, determine the internal moment that is present midway between A and B and clearly specify its sign.

13. (20 points). Determine the resultant internal loadings (forces and moments) at Point B. Clearly indicate whether the moment causes compression on the top or on the bottom of the beam. Indicate the sign of the shear force by drawing an icon with the forces showing the direction in which the shear acts. Given: The beam has a fixed support at Point A and is free at Point C.

14. (15 points). Determine the internal bending moment at point C and indicate whether this moment causes compression on the left or the right side of the beam.
Recognize two-force members and use this to simplify problems, knowing that internal shear and moment must be zero on the cross-section.

15. (3 points) Explain why the reaction component $C_y$ must be zero.

16. (3 points) Determine the internal shear force on the cross-section at the midpoint between B and C, from the previous problem.

17. (3 points) What is the maximum internal bending moment in Member BC, from the previous problem?

18. (3 points) TRUE or FALSE. The cross-section at point F may have internal normal force, but cannot have internal moment or internal shear force.

19. (25 points) Determine the resultant internal loadings (forces and moments) on the cross section through point D.

Given:

Loadings shown.
Point B is an internal pinned connection
Point A is a roller support
Point C is a fixed support
20. (20 points) Determine the resultant internal loadings (forces and moment) on the cross-section through Point I on the drum lifter.
Given: The gripping action on the top of the drum has horizontal and vertical force components, only.

![Diagram of drum lifter with Point I and gripping action](image)

21. (30 points) Determine the internal normal force $N$, the internal shear force $V$, and the internal moment $M$ at cross-section $F$, due to the applied loads. For the internal moment, specify whether the moment causes compression on the left or on the right. For the internal normal force, specify whether it is in compression or tension.
Given: Member $ABC$ is connected to member $CDE$ by a pin. Pinned supports at $A$ and $E$. Loadings and dimensions as shown. (partial ans: $M_F = 10.6$ kip-ft, compression on the left)

![Diagram of member ABC connected to CDE with pinned supports at A and E](image)

22. (40 points) Determine the magnitude of the internal moment $M$ at point $F$ and specify the sign of the internal moment.
Given: Member $ABFC$ is a continuous member that is connected to member $CDE$ by a pin at $C$. There are pinned supports at $A$ and $E$. There is a uniformly-distributed loading of 1 kip/ft from $B$ to $C$ and a uniformly-distributed loading of 2 kips/ft from $C$ to $D$. 

![Diagram of continuous member ABFC connected to CDE with pinned supports at A and E](image)
• Define normal and shear stress.
• Determine when the F/A and V/A equations are applicable (instances of uniform stress) and when they are not applicable (instances of non-uniform stress).

23. (3 points) TRUE or FALSE. The maximum normal stress on this beam is equal to P/A.
   Given: The beam shown has a cross-sectional area of A.

24. (3 points) TRUE or FALSE. For previous beam, the maximum normal stress on this beam is equal to P/A.

25. (3 points) True False. For the previous beam, the average shear stress at the left support is equal to P/(2A).

• Compute normal and shear stresses on uniformly stressed bodies.

26. (20 points) Determine the normal stress $\sigma_{a-a}$ and shear stress $\tau_{a-a}$ on cross-section a-a if the cross-sectional area is 1 in$^2$. 
ANSWERS TO QUESTIONS 1 TO 26 OF THIS GUIDE

1. 3
2. 2
3. 1st, solve FBD ADB, then solve FBD BEC
4. 0
5. FALSE
6. FALSE
7. 3
8. 6
9. 4 external unknowns are solvable as one FBD, making it necessary to cut at internal pin to solve 2 separate FBD’s.
10. 6
11. 25 kip-ft, compression on bottom
12. 7 kip-ft, compression on bottom
13. 1152 kip-ft, compression on bottom
14. 92 kip-ft, compression on left
15. BC is a 2FM. Reaction is horizontal. Cy=0
16. 0. 2FM: V=0
17. 0. 2FM: M=0
18. TRUE
19. M=13.5 kip-ft (compression on top). V = 0.75 kips (positive)
20. N=250 lbs (T), V= 144.3 lbs, M=1155 ft-lb (compression on left)
21. N=5 kips ©, V=30/17 kips, M=180/17 kip-ft (compression on left)
22. 25 kip-ft, compression on bottom
23. FALSE
24. FALSE
25. TRUE
26. \(\sigma_{aa}=2500\text{psi (T)}, \tau_{aa}=0\)