#	Question	Answer(s)
1	are there any other resources to study than previous exams?	Lecture notes and homework problems will be a good start. We will also have review problems in discussions next week and a review session next Thursday.
2	Are eigenvectors properties of a matrix? As in do you say “the eigenvector of matrix A”?	live answered
3	when eigenvectors don't change direction after getting transformed by a matrix A, does that also mean the eigenvectors are in their original spans?	Correct. In fact, generally, when we refer to the eigenvector, we actually referring to the span of said eigenvector.
4	Can a matrix have multiple eigenvectors?	Yes
5	are all vectors in the eigenspace eigenvectors?	Yes
6	Eigenspace is the space generated by eigenvectors scaled by any scalar, not just their eigenvalues?	Correct. The eigenspace is the vector space spanned by the eigenvector (potentially multiple eigenvectors if a given eigenvalue has multiple eigenvectors).
7	could you give an example where the eigenspace is R2?	The identity matrix has the eigenspace R2
8	what is the A matrix?	In the first example, [2 0, 0 2]
9	what are the answes of the first animation?	Matrix is scaling, [2 0;0 2], eigenvectors are any R2 vectors except 0, eigenvalue is 2.
10	can someone please explain the A-lambda*I nullspace meaning again?	We set up that eigen problem as Ax = lambda * Ix, where I is the identity. Then we rearrange the problem to get a null space problem A-lambda*I. So the null space will be our eigenvectors / eigenspace, depending on the lambda.
11	What does it mean for the eigenvectors to be in the "whole 2d space"? Is it different from r2?	It is basically R2 except the 0 vector. Remember we cannot have 0 vector as an eigenvector.
12	can you restate the enaswer for the second animation?	The matrix is scaling in just 1 direction. The A matrix is [1 0, 0 2]. Its eigenvalues are 1 and 2, with the associated eigenvectors of [1 0] and [0 2]
13	what are some of the eigenspaces for these gif examples?	After finding all eigenvectors corresponding to the same eigenvalue, the span of those eigenvectors will be an eigenspace

14	can you restate the enaswer for the third animation?	The matrix is a sheer matrix. I think it was [1 0, 1 1], or something similar. It only has the eigenvalue 1, and associated eigenvector [1 0].
15	I thought the rotation matrix rotates counterclockwise?	live answered
16	is clockwise positive?	live answered
17	what's the A matrix for the rotational matrix? my wifi cut out :((((	[cos theta sin theta -sin theta cos theta]
18	is does that last example have eigenspace R2?	Yes
19	If it moves 90 degrees is it still an eigenvector or is only when it moves 180 degrees	Only 0 or 180 degrees
20	Is there a specific notation for showing that only vectors on the x and y axis are eigenvectors?	Nope, we can just state that in words
21	what is the A matrix for the matrix that reflects along a line(the current example)?	Assuming this line is y = x, then the matrix is [0 1, 1 0]. But it depends on the line.
22	I'm not understanding why eigenvectors are not unique if there are specific eigenvalues corresponding to them?	If x is an eigenvector corresponding to lambda, then alpha*x where alpha is not zero will also be an eigenvector
23	how do you find the eigenspace?	Finding the eigenspace is equivalent to finding all the eigenvectors for a given eigenvalue. The eigenspace is simply the span of all those eigenvectors.
24	why is eigenvalue 1 in this problem?	live answered
25	so when asked how many eigenvectors, we can just say "one" instead of like writing out the set of all vectors on the line?	Yes. Even though the whole span of an eigenvector shares the properties, we just refer to it as the one eigenvector.
26	Does one eigenvalue only corresponds one eigenvector ?	i dont think so; u can have one unique eigenvalue for multiple eigenvectors like the first matrix ex we saw
27	is it an eigenvector if the vector is perpendicular to the flip line	Yes, that is another eigenvector for this
28	If there's 2 unique vectors, how is the eigenspace just the line of reflection? Would it not be the whole 2d space?	it only spans that line

29	is the eigenspace just the span of the eigenvectors?	yup! specifically the eigenvectors associated with a given eigenvalue.
30	how do you find the A matrix?	Good question. One way to do this is to look at how the matrix A transforms the identity matrix, i.e. the elementary basis, and use that to form the matrix. We'll see it more when we talk about Change of Basis next lecture.
31	should we know the A matrix for this transformation(refelction)?	sure. it's a fairly common one. we'll see it again in discussion.
32	are the vectors orthogonal to the line the eigenvectors?	live answered
33	does the eigenspace span r2?	Nope, since the two eigenvectors correspond to different eigenvalues. Each of them forms a 1D eigenspace.
34	since there can be multiple vectors that are perpendicular, how would we write what the eigenvactors are	You can write out one of them any say that any non-zero scaling of it is also an eigenvector.
35	so what is the space now given the perpendicular	The first eigenvalue / vector pair is 1, [1 1] (parallel to the line). The other pair is -1, [-1, 1] (perpedicular to the line).
36	i still dont see how eigen values refers to page rank	It relates to the steady-state of traffic flows between webpages. We will see that soon.
37	What does it mean to compute the eigenvector of all the images? The images aren’t matrices, right?	While we have used images as vectors in lab, we can still represent them as matrices. The simply theory is that a given matrix may have a bunch of eigenvalues, but only a few large / principle ones, and those are the ones we care about for e.g. machine learning. This is covered in EECS16B.
38	I haven't had a chance to do the recording for HW3 yet due to hectic schedules and classes...Would it still be possible for me to try doing it today or some later date?	Yes please have a try and make sure you (and your computer) are comfortable with the exam setting (and recording)

39	Why do we need a det here	We want to find the lambdas that give us a nullspace. We are using the determinant as a condition for that.
40	i dont understand why do we use the determinant to find eigenvalues	From the (A-lambda*I)v = 0 setup, we know we want (A-lambda*I) to have a null space, so we need to find the cases of lambda where a null space exists. We know that a null space will exist if the columns are linearly dependent, which happens if the determinant is zero. So we're solving for when lambda makes the determinant zero.
41	can anyone remind me how/why we go from (A-\lambda)x=0 to det(A-lambda)=0?	To find the eigenvalues, we want to find the \lambda's that result in non-zeros solutions to (A - \lambda I)x = 0, which is equivalent to a non-trival null space of (A - \lambda I). We know that det(A - \lambda I) = 0 means there is a non-trival null space.
42	why do we need to find the null space here?	From the (A-lambda*I)v=0 setup, we want v to be in the null space of (A-lambda*I).
43	what happened to the lambda = 2? why did we not use it?	We've only looked at one of them so far
44	does it matter whether we chose lambda to be 1 or 2 before plugging in and doing gaussian elimination?	We want to do both eigenvalues to find out the corresponding eigenvectors.
45	what about lambda = 2??	i am also wondering this
46	How would we find v_2 here?	We would use the same method we did for finding v_1, but substitute lambda = 2 in instead of lambda = 1
47	in the case that both the eigenvalues are the same, how would you represent a non-eigenvector as a combination of the eigenvectors of that specific matrix?	A linear combination of eigenvectors corresponding to the same eigenvalue will still be an eigenvector of that eigenvalue.
48	can all vectors in the span be written with the eigenvectors? so eigenspace = space?	Note that since the two eigenvectors correponding to different eigenvalues, we don't call their span an eigenspace. It's a vector space though.
49	How did we get v3?	v3 is another vector from the example animation, [1 1]
50	Why is it A(lambda * v1 + lambda * v2)	We're specifically looking at A^2 * v_3. So we've done 2 multiplications with A.

51	can you go over the first calculation of A2?	We know Av_3 = (lambda_1*v_1 + lambda_2*v2) from the previous slide. So we just multiply both sides by A.
52	is v3 in the eigenspace and is this why we can do that calculation?	v3 is not in the eigenspace, but we represent it as a linear combination of v1 and v2 (which are eigenvalues), and we can then distribute A to each terms.
53	if v3 = nv1 + mv2 instead of just v1 + v2, do we include those scalars n and m in our calculations?	yes!
54	is the eigenspace the span of v1 and v2?	Not necessarily. Since we have eigenvalues associated with v1 and v2 are different, then their eigen spaces are separate.
55	what do u mean by "if there is a steady state"??	Sometimes a steady state does not exist. The system may decay to 0, or blow up to inf.
56	how do we know that lambda is 1?	Steady state is when Ax = x, i.e. the A transform doesn't change x. So the eigenvalue must be 1.
57	the steady states are always eigen vectors?	steady states are eigenvectors corresponding to the eigenvalue 1
58	can you scroll back up?	live answered
59	what's the difference between the eigenvector we find and it's span?	Any vector except 0 in the span of a eigenvector will also be an eigenvector. Typically in the page rank problem we will put some constraints to the vector (like the elements sum up to 1) so we know which eigenvector we want.
60	since theres no lab this week do we still have to attend the section?	Yes, there will still be discussion tomorrow
61	Why is it not -1/4 1/4 1/2 -1/2?	We first were looking at the case with lambda = 1/4. Next we will do lambda = 1
62	How did we get v1?	We solve the equation (Q-lambda * I)x = 0 by Gaussian elimination, and plug in lambda = 1/4
63	could you please scroll down a bit?	live answered
64	why are we looking for a row of zeros for null space	Recall that a row of zeros in GE means we have linear dependence and infinite solutions. This is what we want for the null space, since we're looking for vectors to span the null space.

65	if we found eigenvectors, can we describe any vector in terms of a linear combination of eigenvectors?	Sometimes eigenvectors do not span the entire R2 space. In that case we cannot express any vectors by eigenvectors.
66	can we get linearly dependent eigenvectors?	For the same eigenvalue, yes
67	can we alsways write all vectors from lin comb of eigenvect or just this case?	It won't always be the case. but if we have a set of linearly independent eigenvectors (regardless of the eigenvalues), then we can write the linear combination.
68	Would you mind explaining again how you found v1 and v2?	v1 and v2 were found from looking the null space vectors for the (A-lambda*I) problems.
69	so if we have linearly dependent eigenvectors then we won't be able to represent any vector as a linear combination of them as Prof. Waller is demonstrating right now, right?	This is true, but usually the problem won't be dealing linearly dependent vector, but instead not having enough LI vectors (consider the sheer transform we looked at earlier).
70	what if lambda = -1?	In this system, it means we will switch back and forth between a couple states.
71	what is alpha?	live answered
72	if it is a conservative system then all LAMBDAs are 1?	We will have at least one lambda = 1, but not all of them
73	why cant we plug in the values of lambda1 and 2?	