3) From the class notes discuss why study of the galaxies in the local group is important for our understanding of more distant galaxies- what can we learn about stars and their evolution and their IMF from the local group that is hard to learn about more distant objects.

As is clearly in the class notes
The local group is close and bright- all the galaxies are nearby enough that individual stars can be well measured as well as HI, H2, IR, x-ray sources and even γ–rays.
There is a wider sample of the universe than the MW alone (e.g. range of metallicities, star formation rate etc) to be studied in detail.

4) Compare and contrast the 3 spirals in the Local group (MW, M31, M33) –e.g. what is different about their mass distributions, their star formation etc.

Discuss the velocity profile of the 3 systems, the 'deconstruction' into stars, gas and dark matter, the mass of the systems and their star formation. They can also mention the mass of the central blackhole.
Direct quote from class notes slide with title ' Comparison of Rotation Curve for MW, M31,M33'

5) In Spirals what:
a) are the dynamics of their 2 major components (disk and bulge)?
Bulge is supported by 'random motions' of stars (e.g dynamically hot) and the disk by rotation
b) is a distinguishing property of the halo: it is dark matter dominated, stars are old and metal poor,

6) Along the Hubble tuning fork spiral sequence give 3 things that change systematically as on goes from S0 to Sd and how they change.

See the lecture notes on Spirals where it says

- ' Galaxies have a wide variety of morphologies, from spheroids , disks with and without bars and irregular galaxies.
- Their physical properties (e.g. gas content, average stellar age, the rate of current star formation, mass etc) correlate with morphology.

and in detail
The Hubble type of a spiral *correlates* with

- bulge/disk luminosity ratio :decreases as go from S0 to Sd
- relative amount of cool gas (H I and H_2) increases as go from S0 to Sd
- mass concentration: decreases as go from S0 to Sd
- stellar population (how many young/old stars) increases as go from S0 to Sd
- nuclear properties **(nature of AGN**)- does not change
- chemical abundances in the ISM- complex
- star formation history and integrated stellar spectrum: more star formation as go from S0 to Sd and spectrum gets 'bluer'

7) a) What does the term 'luminosity function' mean?:
'the number of galaxies per unit luminosity per unit volume'
b) What is the general form of the luminosity function and what are its important parameters and what do they 'mean'.
The Schecter function
$f(L) = n(L/L_*)^{-\alpha}\exp(-L/L_*)$; where L* is a characteristic luminosity, α is the low luminosity slope and n is the normalization.

c) How does the luminosity function of spirals and ellipticals differ?
See figure in notes:the elliptical one is biased towards higher masses- I did not give numbers for α and n so a one can be a bit 'weak'in the answer.

8)a) What is the general form of a galaxies surface brightness ?
the Sersic law:
$S(r)=S(0)\exp(-k [(r/r_e)^{1/n}-1]$ where n and r_e are parameters to be fit for

b) what is the asymptotic form of this surface brightness law for spirals and ellipticals
for spirals it is n-=1 which is an exponential; for ellipticals n~4 and the deVacouleurs law $I(R)=I(R_e)(\exp-7.67[(R/R_e)^{1/4}-1]))$ is often used.

c) what is the meaning of the term 'scale length': it is a characteristic length scale which allows measurements of the 'size' of the system and its mass. For spirals it is the 'e-folding' scale; for ellipticals it is the half-light radius.

9) a) what is the 'spider diagram" and what does it tell us about galaxy inclination and velocity field?
The spider diagram (see S&G fig 5.19) contours of constant Vr ; the spider diagram connects points with the same value of $V(R) \cos \phi$

b) What is the 'Tully Fisher' relation and what does it tell us about the relationship of light and mass in spirals?

The T-F is an empirical relationship that connects the luminosity of a spiral galaxy with the maximum rotational velocity, v_{max}). Since it connects a term (v_{max}) with light it connects the total mass of the galaxy (which is mostly dark matter) with the star light.. a very unexpected result. To quote from the class notes

- Relationship between the speed at which a galaxy rotates, V, and its optical luminosity L_{opt}: (the normalization depends on the band in which one measures the luminosity and the radius at which the velocity is measures) $L_{opt} \sim A v_{max}^4$
- Connects galaxy dynamics to optical luminosity

10) What is meant by 'winding up' of spiral arms and what does this tell us about their origin and how long they live??

This is the effect that the galaxy's *differential rotation* would wind up the spiral As time goes on, this spiral becomes ever more closely wound resulting in the arms rapidly transitioning into a very tight curl.
For more points They might also add the timescale on which this occurs

Near the Sun's position in the Milky Way, where $V(R) \approx 200$ km s^{-1} is nearly constant and $R \approx 8$ kpc, the pitch angle i of Equation 5.8 tightens according to

$\cot i = R\, [d\Omega(R)/dR]t$

$t \approx [200/8] t_{Gyr}$

So the origin of the spirals arms is not primarily differential rotation.