Or

$V(t)=\frac{1}{2\pi kv}\frac{d\phi 1(t)}{dt}$ (2.84)

Conclusion

here, it can be concluded that if the magnitude of L(f) is very large for all frequencies of interest,then PLL may be modelled as a differentiator with its output scaled by a factor $\frac{1}{2\pi kv}$.it has been illustrated in fig.2.22(b).

the simplified model of PLL as shown in fig.2.22(b) may be usd as an FM demodulator. This can be easily verified by substituting the value of $\varphi_1(t)$ from equation.

$\varphi_1(t)=2\pi k_f \int_0^t x(t)dt$ into equation (2.84)

∴ we have

$V(t)=\frac{1}{2\pi kv}\frac{d\phi 1(t)}{dt}=\frac{1}{2\pi kv}\frac{d}{dt}\left\{2\pi kf \int_0^t x(t)\,dt\right\}$

Or

$V(t)=\frac{2\pi kf}{2\pi kv}\frac{d}{dt}\left\{\int_0^t x(t)\,dt\right\}$

$V(t)=\frac{kf}{kv}x(t)$

(2.85)

Hence, we can say the output V(t) of PLL is approximately same except for a scaling factor $\frac{kf}{kv}$, as the original baseband or modulating signal x(t) and the frequency demodulation is performed

TWO MARKS

1. What do you understand by narrowband FM?

When the modulation index is less than 1, the angle modulated systems are called low index. The bandwidth requirement of low index systems is approximately twice of the modulating.

2. Define frequency modulation.

Frequency modulation is defined as the process by which the frequency of the carrier wave is varied in accordance with the instantaneous amplitude of the modulating or message signal.

3. Define modulation index of frequency modulation.

It is defined as the ratio of maximum frequency deviation to the modulating frequency.
$\beta = \delta f / f m$

4. What do you meant by multitone modulation?
Modulation done for the message signal with more than one frequency component is called multitone modulation.

5. Define phase modulation.
Phase modulation is defined as the process of changing the phase of the carrier signal in accordance with the instantaneous amplitude of the message signal.

6. What are the types of Frequency Modulation?
Based on the modulation index FM can be divided into types. They are Narrow band FM and Wide band FM. If the modulation index is greater than one then it is wide band FM and if the modulation index is less than one then it is Narrow band FM

7. What is the basic difference between an AM signal and a narrowband FM signal?
In the case of sinusoidal modulation, the basic difference between an AM signal and a narrowband FM signal is that the algebraic sign of the lower side frequency in the narrow band FM is reversed.

8. What are the two methods of producing an FM wave?
Basically there are two methods of producing an FM wave. They are,
i) Direct method: In this method the transmitter originates a wave whose frequency varies as function of the modulating source. It is used for the generation of NBFM
ii) Indirect method: In this method the transmitter originates a wave whose phase is a function of the modulation. Normally it is used for the generation of WBFM where WBFM is generated from NBFM

9. Compare WBFM and NBFM.

S.NO	WBFM	NBFM
1	Modulation index is greater than 1	Modulation index less than 1
2	Frequency deviation 75 KHz	Frequency deviation 5 KHz
3	Bandwidth 15 times NBFM	Bandwidth 2fm
4	Noise is more suppressed	Less suppressing of noise

10. List the properties of the Bessel function.
The properties of the Bessel function is given by,
i) Jn (β)=(-1)nJ-n(β) for all n, both positive and negative.
ii) ii) For small values of the modulation index β ,we have
J0 (β)=1
J1 (β)=β/2
Jn(β)=0,n>2.

11. Give the average power of an FM signal.

The amplitude of the frequency modulated signal is constant .The power of the FM signal is same as that of the carrier power.

$P=1/2\ Ec^2$.

12. Define phase deviation.

The maximum phase deviation of the total angle from the carrier angle is called phase deviation.

13. Define frequency Deviation.

The maximum departure of the instantaneous frequency from the carrier frequency is called frequency deviation.

14. State the Carson's rule.

An approximate rule for the transmission bandwidth of an FM Signal generated by a single tone-modulating signal of frequency f m (max) is defined as

$\therefore BW=2[\delta + f\ m(max)]$

15. Define the deviation ratio D for non-sinusoidal modulation.

The deviation ratio D is defined as the ratio of the frequency deviation f, which corresponds to the maximum possible amplitude of the modulation signal m (t), to the highest modulation frequency.

$D = \Delta f/ f\ m$

16. What is the use of crystal controlled oscillator?

The crystal-controlled oscillator always produces a constant carrier frequency there by enhancing frequency stability.

17. What are the disadvantages of FM system?

1. A much wider channel is required by FM.

2.FM transmitting and receiving equipments tend to be more complex and hence it is expensive.

18. How will you generate message from frequency-modulated signals?

First the frequency-modulated signals are converted into corresponding amplitude- modulated signal using frequency dependent circuits. Then the original signal is recovered from this AM signal.

19. What are the types of FM detectors?

The types of FM detectors are

(i) Slope detector and

(ii) Phase discriminator.

20. What are the types of phase discriminator?

The types of phase discriminator are

Foster seeley discriminator

Ratio detector.

21. What are the disadvantages of balanced slope detector?

1. Amplitude limiting cannot be provided
2. Linearity is not sufficient
3. It is difficult to align because of three different frequency to which various tuned circuits to be tuned.
4. The tuned circuit is not purely band limited.

22. Write the advantages and disadvantages of foster-seely discrimination method?

Advantages:

a) It is much easier to design

b) Only two tuned circuits are necessary and they are tuned to same frequency c) Linearity is better

Disadvantages:

a) It requires Amplitude limiting circuit.

23. What are the applications of phase locked loop?

Phase locked loops are used for various purposes in AM and FM communication.

(i)Automatic frequency correction in FM transmitter uses PLL to keep carrier frequency constant.

(ii)PLL is used direct FM Transmitter uses PLL to keep carrier frequency constant.

(iv) PLL is also used in FM demodulators.

24. What do you understand by FM stereo multiplexing?

FM stereo multiplexing is used for stereo transmission. It is basically frequency division multiplexing. It is used for FM radio broadcasting. The left and right channel signals are used to generate sum and difference signals. The difference signal frequency modulates the carrier. The difference signal, FM difference signal, FM difference signal and carrier are combined together and sent. Such FM multiplexed signal can be coherently received by stereo as well as mono receiver.

25. A 80 MHz carrier is frequency modulated by a sinusoidal signal of 1V amplitude and the frequency sensitivity is 100 Hz/V. Find the approximate bandwidth of the FM waveform if the modulating signal has a frequency of 10 kHz.

Ans: Frequency Sensitivity = 100 Hz/ volt.

Amplitude of modulating signal = 1V

Hence maximum frequency deviation, δ =100 Hz / volt ×1V= 100 kHz

Frequency of modulating signal, fm = 10kHz

$\therefore$ BW = 2 [δ + f m (max)

= 2 [100 +10×103]

BW = 20.2 kHz

26. Obtain the bandwidth of the FM signal.
c (t) =10 × cos [2 ×10 7 ×π t + 8 cos (1000 ×π t)]
Ans: Compare the given FM signal equation with standard FM signal equation,
c (t) = Ec cos (ωc t + m cos ωm t)
Here, m = 8 ,ωm =1000 π , Hence 2π f m =1000 π or f m = 500 Hz
δ = m f m = 8× 500 Hz = 4000 Hz
BW = 2 (δ + f m (max))
= 2 (4000 + 500) = 9000 Hz or 9 kHz

27. State the disadvantages of FM.
i) Bandwidth requirement of FM is much higher.
ii) FM transmitting and receiving equipment is more complex and costly. iii) Distance of reception is limited only to line of sight.

16 MARK QUESTIONS
1. Explain the indirect method of generation of FM wave and any one method of demodulating an FM wave.
2. Discuss the indirect methods of generating a wide-band FM signal.
3. Draw the circuit diagram of Foster-seeley discriminator and explain its working.
4. Derive an expression for single tone FM wave and Narrowband FM wave?
5. Discuss the working of FM using Armstrong method